Oxy | MDes Project | Oliver Miller
Logbook

Contents

Introduction

Sport has a major influence on peoples lives culturally, socially and psychologically. Even before modern civilisation sport has been prevalent, whether the activity was devised by different military groups so they could identify the stronger individuals for their army or whether it was horse riding in the middle ages, sport is “a banal necessity of everyday life” (Bush, 1998) and will continue to be, as the sporting industry is set to be worth $73.5 billion by the year 2019 (Heitner, 2015).

In modern civilisation wherever there is sport, there is advertising, marketing, training, design, engineering, and individual sporting heroes as well as many other factors that help shape what we see when we think of sport in society. However, sport goes past this, sport transcribes the message of optimism, fun and most importantly democratic participation within a physical activity. It gives the opportunity for humans to entirely focus on a specific task for a duration of time in a very immersive and competitive environment. This immersive experience that is then paired with competition/ performance enhancement generates a vast amount of passion for the participants. The passion people have for sports and sports teams for certain individuals develops into more than a sport. A sporting team for some, is a way of life. They develop a connection with not only a team, but with the mutual fans, the teams city and this translates into their identity.

Sport is used on world stages, just like the Olympics to bring countries together where borders do not matter and individuals have the opportunity to show their physical and mental attributes against others from around the globe. This is a very rare occurrence within modern society and events like the Olympics allow the world to celebrate not only individual achievements but the unity and collaborative success we can have when the world works together.

Fig. 001

Over the years in sporting events like the Olympics, athletes have been running faster times, throwing further distances and lifting heavier weights. This comes down to a number of development factors such as intelligent training, sports engineering, biological understanding, nutrition and product design.

Sport Around The Globe

Just like it was stated within the introduction, sport is not blocked by international borders. The undeniable human need for play allows is a motivating factor in why sports is and will always be part of human life.

However our thoughts towards sports in the UK, may be completely different to another individual on the other side of the globe but our human instinct towards sport is still very familiar. The change in views comes when aspects like sporting facilities, physical education and government funding change our public perception of sports. Every child around the world will still want to take part in some adaption of physical play.

Kevin Carroll - The Art of Sport and Play

An example of this was Kevin Carroll's exhibition on Within the exhibition are examples of children's sports balls from around the globe. This portrays that where ever are situated around the globe, people have a human urge to play sport what ever their financial, social, or cultural situation.

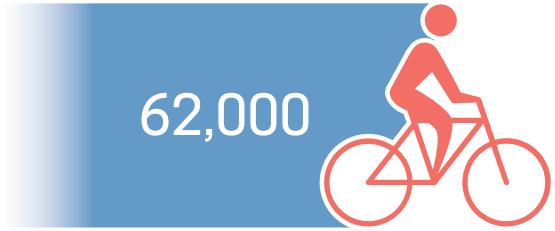
Fig. 002

The Industry

The sporting industry has provided experiences, jobs and enjoyment for generations. This has led to it becoming a large contributing factor not just for everyday life but for the nation's economy. Over the last 5 years sport has become a £20 billion industry (Cave, A. 2015).

Factors like sports engineering, technology advances, research, advertisement and sponsorship have all contributed to the growing sports industry. Although the industry has a large focus on the amount of participants and viewers, who are playing and attending sports events their is also a focus within the industry on what can be done to help individuals achieve their sporting goals, small or large.

£1 Billion has been committed by the Government to fund sport in schools through 2016.
(Cave, A. 2015)



London 2012 and it's legacy has helped create 62,000 jobs (Cave, A. 2015)

People regularly playing sport stands at 15.74 million over 12 months, a rise of 1.65 million since 2005/06. (BBC, 2015)

Scoping The Project

It became apparent that for this project their was a vast area in which design and sport overlap. To identify what route would be taken for this project the initial thinking was to look at how examples of sport and product design overlap in the extremities. Below a simple graphic has been designed to show exactly where this project will aim to focus. At each end are two images, the left shows a coffee table designed by the Finnish brand Muoto2, the design uses sport as an influence, taking inspiration from a ballerinas foot for the table legs. On the other end of the scale is a picture showing the aerodynamics of a cyclist to identify aerodynamic engineering possibilities.

With this project the aim is to design a solution that will fall some in between the two projects. With the focus being on designing a human-centered product backed up by research that examines the current advances in technology within the sports industry.

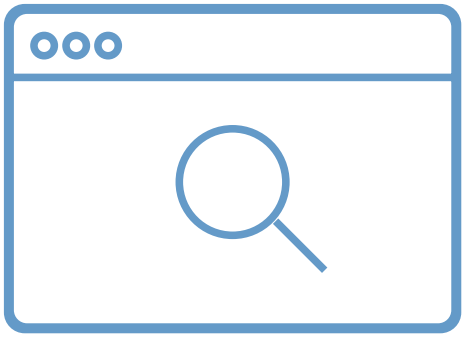



Fig. 003

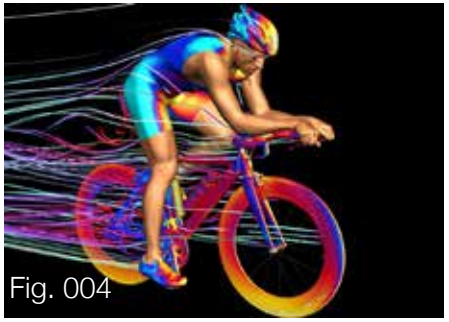
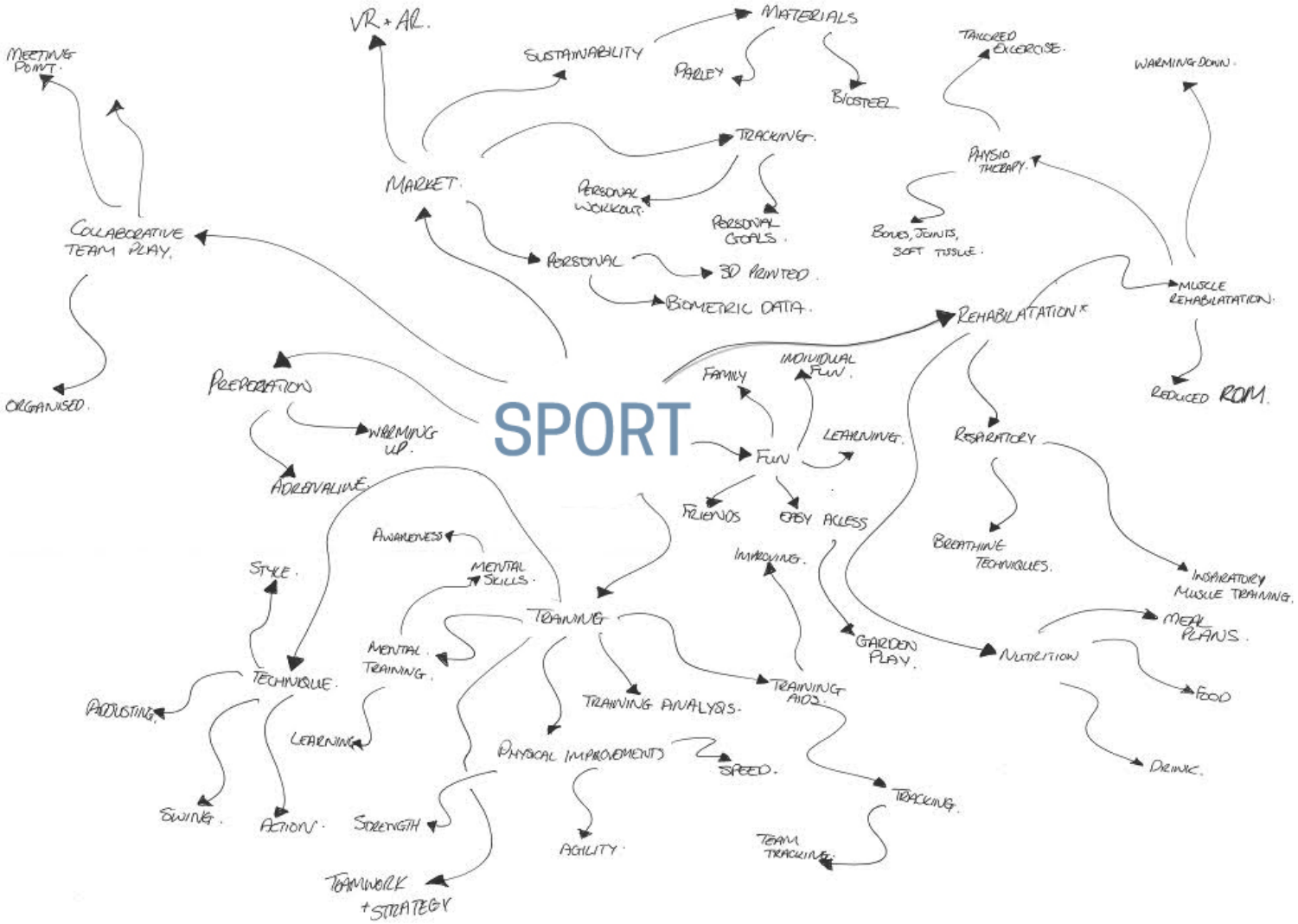


Fig. 004

Design Opportunities

With the project the aim is to quickly identify what is possible for the project to focus on. The line between sports engineering and sports product design is blurred so the aim of this mind map exercise was to identify what possible restrictions and possibilities the project could face.

This exercise has also allowed all possible topic areas to be mapped out.



Identifying A Focus

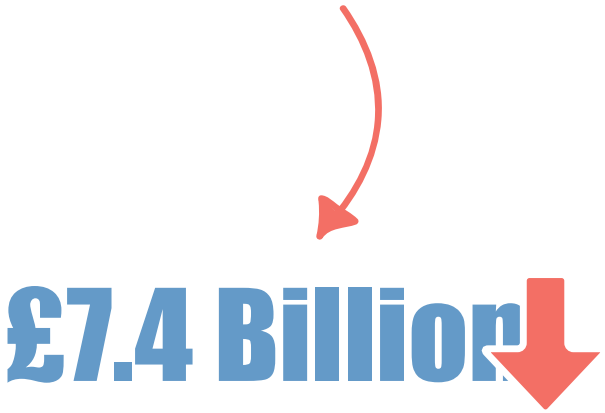
On the initial presentation in which the topic area was discussed a number of possible project opportunities were outlined and discussed.

- The Older Generation
- Mental Training In Sports
- Rehabilitation
- Recreational Play

To the right shows some background research into sport participation. Linking sport participation with a focus from above has allowed the project route to begin.

15.8 million people in England now play sport or exercise once a week (Rhodes, D. 2016)

However....



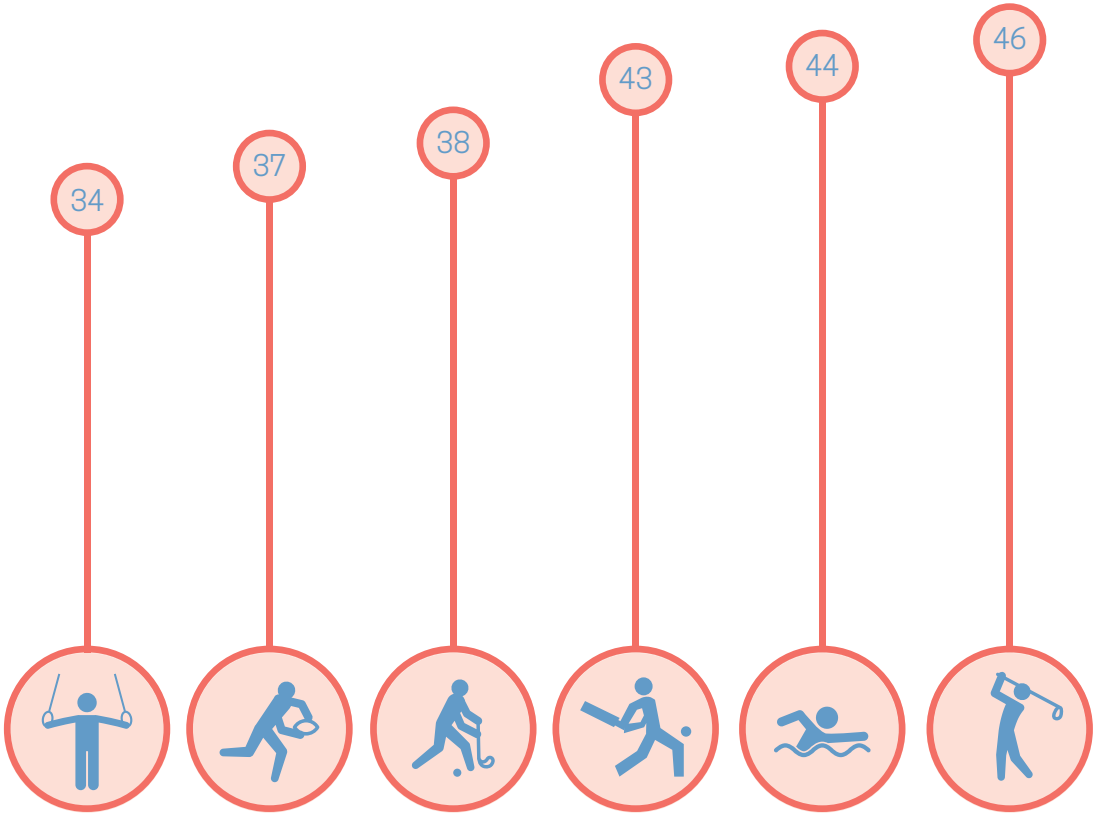
A lack of physical activity is costing the UK economy an estimated £7.4 billion. (Public Health England, 2014)

Older Generation

After the initial research presentation it became clear that a possible route for the project would be to look at the older generation. The research opportunity identified will look at what issues are stopping people from being active when they are of a certain age.

A British Geriatric study suggested that older peoples knowledge about the specific health benefits of physical activity were high amongst the study and that the majority of people believe they partake in adequate levels of physical activity. However when their physical activity was explored it became apparent that many had low levels of leisure time. This has suggested to the study that their is a mismatch in older people between their physical activity beliefs and practice. (Crombie et al, 2004)

Another reason into why older people participation levels in sport drop is due to socio-cultural factors. Many older people once they read a certain age consider themselves “past it” or that they “wouldn’t have the breath”. These could be possible opportunities to look at within the project to explore why people have this stigmatised view on how long they can play sports before. (Sport Scotland, 2016)



A study on 2000 people was undertaken to discover what the average quitting age is for selected sports. (Maynard, G. 2016)

Why Is This Happening?

Sport can become hard for a lot of people to commit to once they reach a certain age for a number of different reasons. However, the reason people stop playing sports is hard to categorise due to individuals stopping sports for a number of different reasons such as life experiences that can vary greatly between individuals.

The research paper, Barriers to Sports and Physical Activity Participation by the Northern Ireland Assembly in 2010 looked at three possible barriers that prevent sports participation in the older generation.

Practical Barriers within sport can be seen as the most obvious reason to an observer as to why people quit playing sports. Practical Barriers refer to factors within peoples lives such as medical, economic, safety, and time pressures that may contribute to people stopping sports.

Practical Barriers

Socio-Cultural Barriers

Knowledge Barriers

Social and culture practices within a community is a big reason why people stop playing sports. The Barriers to Sports and Physical Activity Participation stated that the lack of positive attainable role models was related as contributing factor to the socio-cultural issues surrounding sport.

Knowledge is another barrier that contributes to the older generation stopping sports. Evidence has shown that people in specific groups may not be fully aware of all the health benefits in regards to physical activity.

Walking Football - Case Study

Walking Football is a great example of the older generation playing sports without being hindered by the barriers on the previous page. Sport is still being played by the older generation and walking football is a great initiative that helps get people back into sports.

Their is now over 400 walking football teams within the UK. A Barclays TV advert contributed to bringing it to the mainstream but throughout the UK the participants has grown and grown. Despite the sports name, it still requires a vast amount of mental and physical skills. Walking football was created by Chesterfield FC Community Trust in 2011 and was designed to help get over 50's out of their armchairs and to get back into playing sports. (Rowe, S. 2015)

Fig. 005

"A lot of the men who join in are doing so when their working life is coming to an end. Retirement for some can mean a loss of sense of purpose. You lose the day-to-day social interaction and the physical activity you've had for 40-odd years."

- Walking Football Founder, Steve Rich


Fig. 006

Tutorial One

During tutorial one the project proposal was discussed. The initial conversation was directed towards the older generation within sports and identifying why peoples sport participation levels drop as they age. Some of the key reasons this occurs has been displayed below.

There are many preventing factors that were outlined within the tutorial. However, injury scares, and physical health were showing early signs that they could potentially have the most scope for the project. With a product design response required these two subject areas show the most potential for the project.

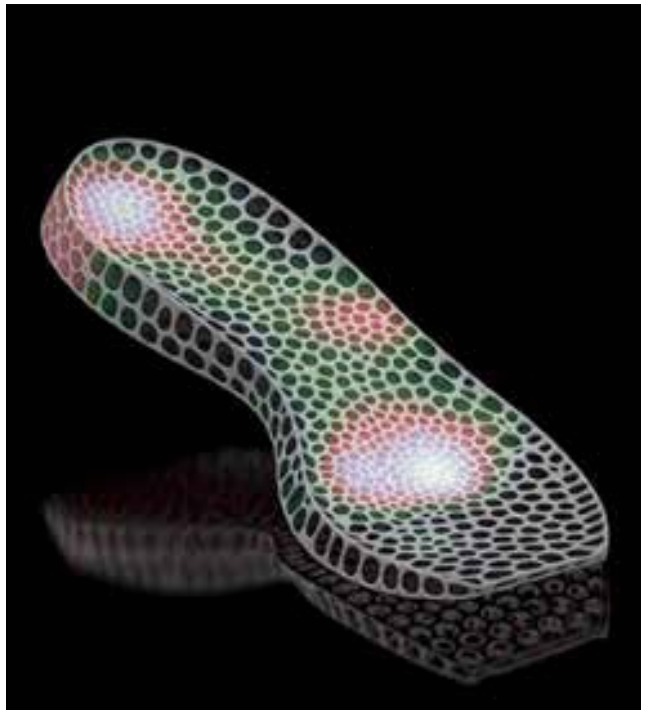
These two preventing factors were quickly made apparent that they are due to socio-cultural barriers. This has meant that they possibly require a service or an initiative to be set up to allow the older generation to really get back into sports.

Potential Response

Within the project it has become clear that the best solution to help get older people back into sport has pointed to socio-cultural solutions for example, walking football. This initiative was set up and works so well due to the solutions simplicity. It offers a simple solution to the older generation that allows them to take part in sport using an organised weekly event.

As a response to this it was decided that maybe the older generation was not the correct path. Whenever research was constructed into this specific topic area their was always thoughts looking into it for a product design response. It became apparent that some of the most suitable responses could have been easily adapted into a system or an initiative.


Fig. 007



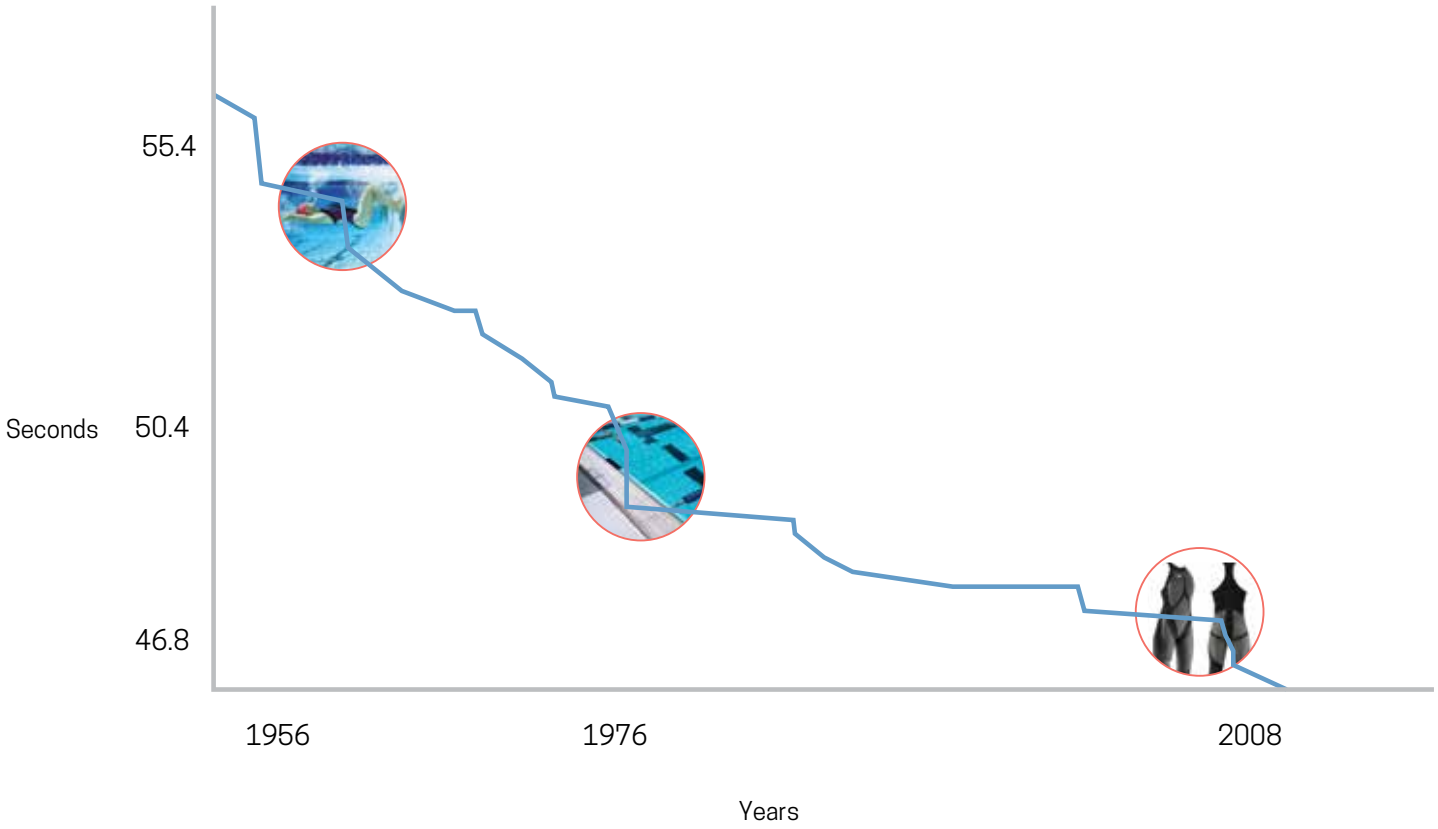
As well as this within the project, the aim is to design a product that will use and take advantage of immerging technologies, aiming my product at the older generation contradicted this.

The pictures above show were taken from a New Balance video, promoting their new 3D printed trainers that adapt the sole structure to the pressure supplied by the user.

David Epstein -Are Athletes Really Getting Faster, Better, Stronger?

David Epstein constructed a TED talk to discuss whether athletes are really getting faster, better and stronger. Within sports there a number of factors that influence performance. However, the big assumption has been that humans have developed physiologically over the past 100 years. Intelligent training, nutrition and anatomy knowledge have all influenced athletes within sporting performance.

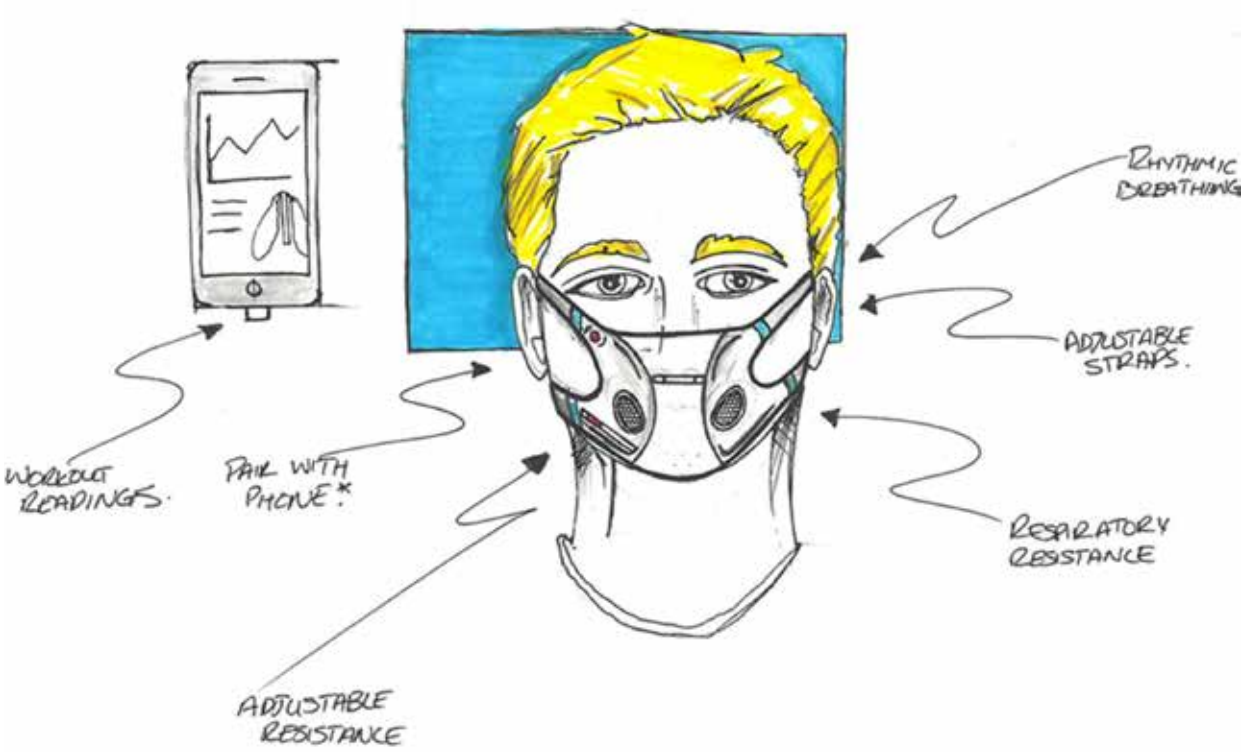
Athletes have been influenced by these factors, however groundbreaking advances in technology have been responsible for some of the biggest sporting achievements. An example of this is the graph to the right. This shows the 100m freestyle world record times. The biggest and most drastic drops all link to advances within technology and sporting developments. In 1956, the “flip-turn” was introduces into swimming, then in 1976, pools were developed with gutters to remove turbulence within the race. Then lastly in 2008 was introduction of full-body and low-friction swimsuits. (Epstein, D. 2015)



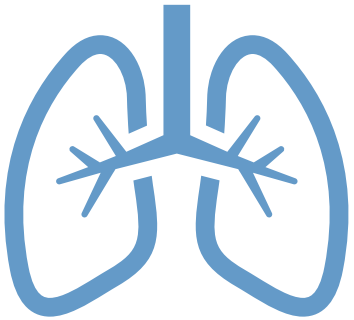
Presentation

During the early presentations, the project was at a point were a direction needed to be decided, three themes were selected.

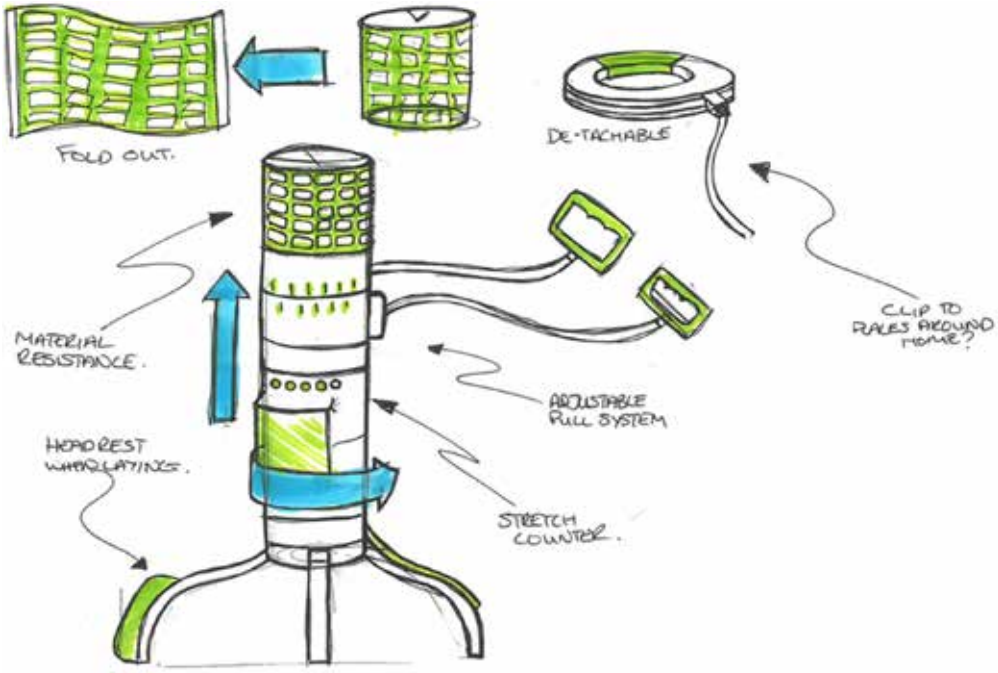
Respiratory Muscle Training

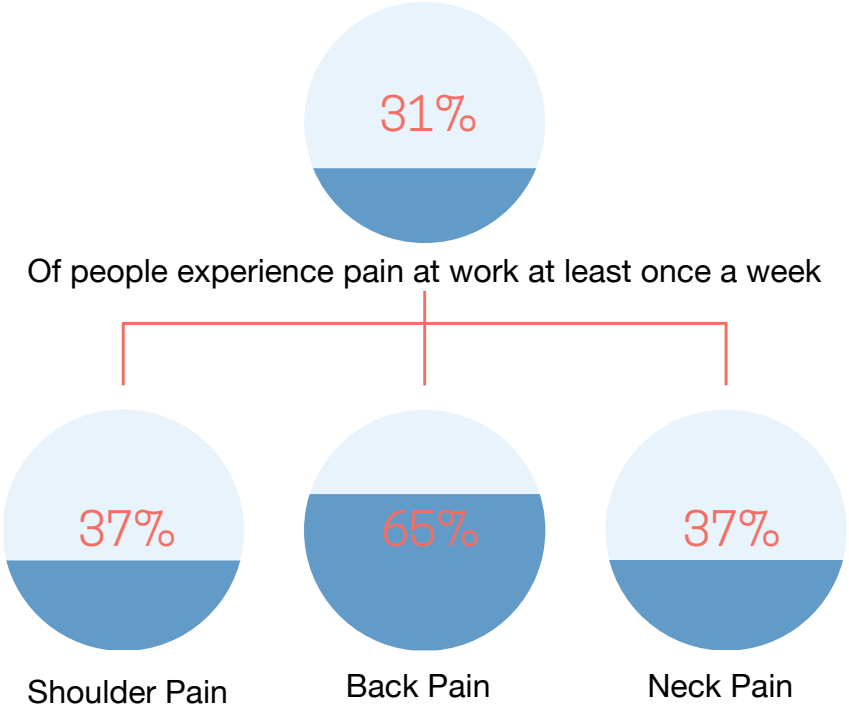


Respiratory Muscle Training focuses on training the respiratory muscles to help aid sporting performance. Using specific exercises Respiratory Muscle Training is used within sport to help increase the strength of the respiratory muscles therefore increasing respiration for the individual. Studies have been done to show that RMT can be used to improve a persons endurance levels during cardiovascular exercises.



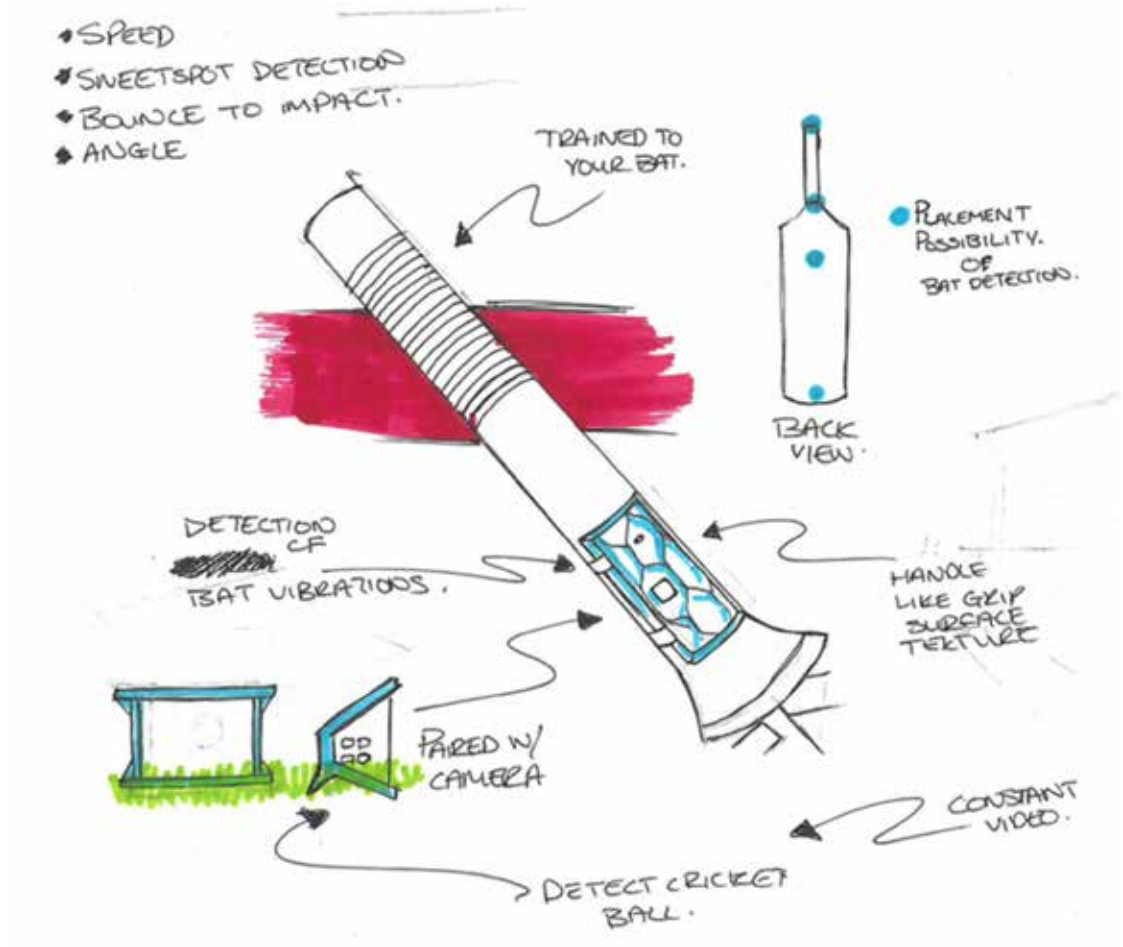
Physiotherapy





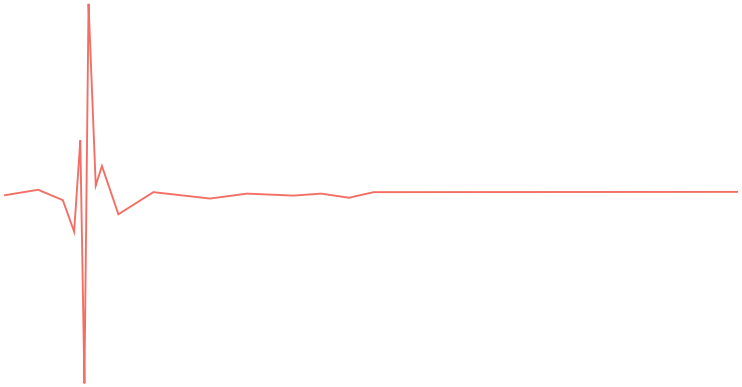
Physiotherapy is a massive part of sport and maintaining sports performance within athletes. 31% of people experience pain at work at least once a week (CSOP, 2012). The concept to the left was looking at physiotherapy within the home to identify whether there was an opportunity for a device to be used within the home that could be used as a physiotherapy modular station.

Cricket Analysis



The third theme that was selected was looking at batting analysis within cricket. From background research into the cricket market it was discovered that there was no batting product analysis products on the market. This concept looks at what a batting analysis product could do and what features could be encapsulated within the design.

This particular theme would however be quite limiting, with little human-centered interaction.



Presentation Feedback

After the presentation, feedback was received, within the feedback we discussed each of the possible themes that were presented to discuss which had the most scope to push forward for the project.

It was decided that Respiratory Muscle Training had biggest opportunity for me to research the project and then to also design a response that could be pushed as a unique product on the sporting market.


Fig. 008

Respiratory Muscle Training

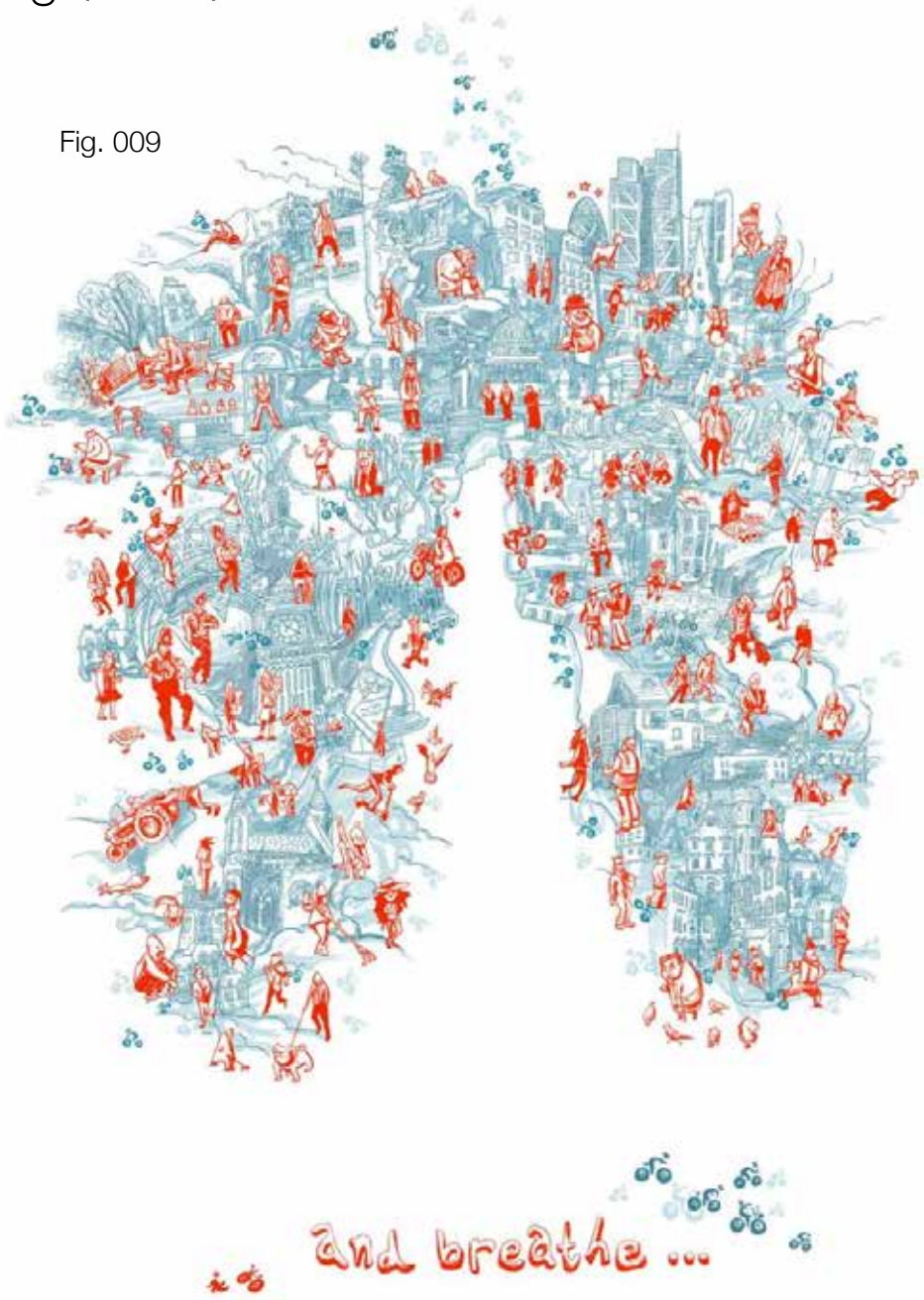
What Is Respiratory Muscle Training (RMT)?

Respiratory Muscle Training (RMT) is a technique that is used to improve the function of the respiratory muscles using breathing exercises. A number of different exercises and breathing techniques can be used to increase the strength and the endurance of the cardiovascular system.

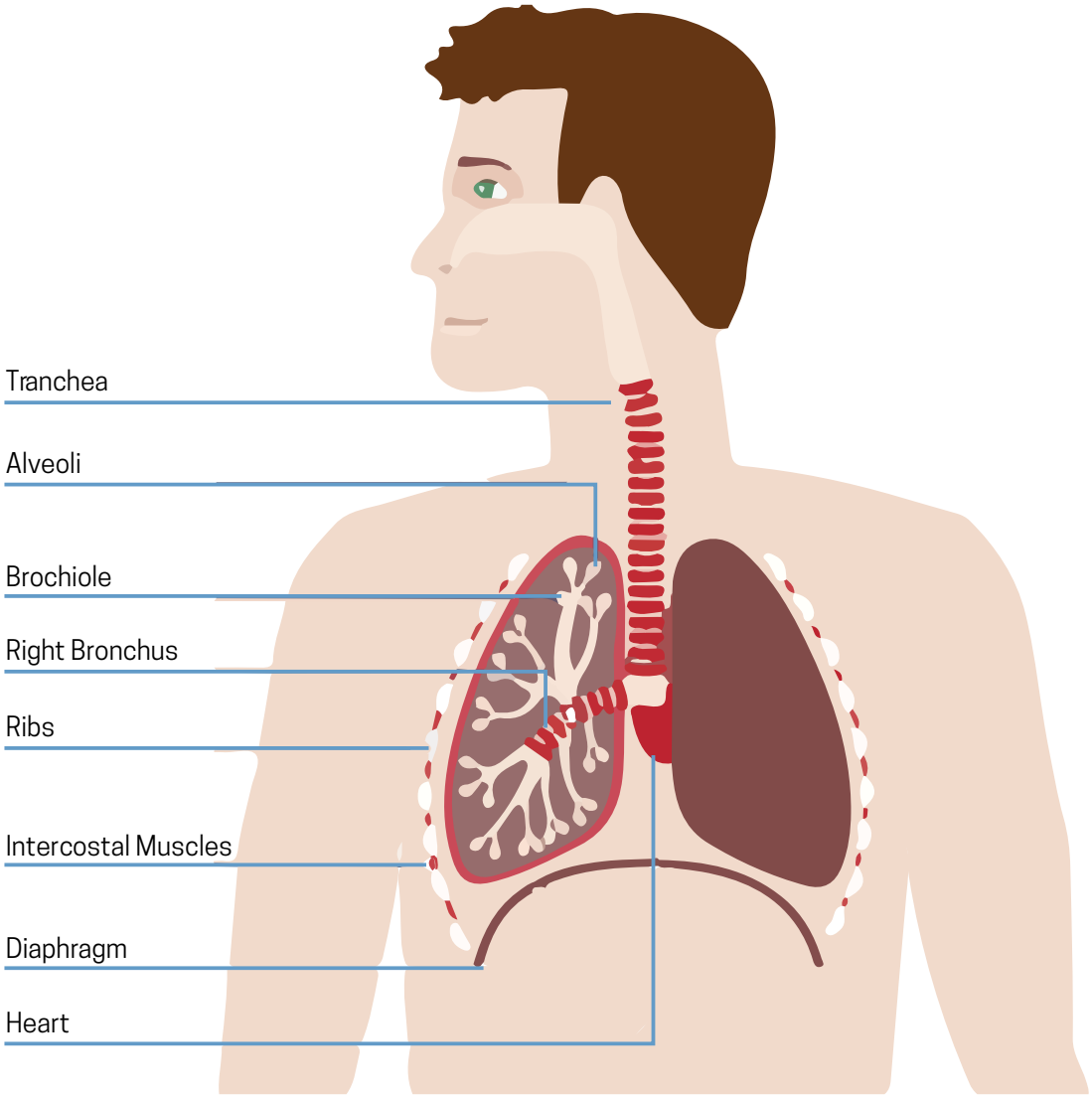
Respiratory Muscle Training can also be used within sports to help enhance sports performance. The benefits of this can be used within a variety of sports and can be used to help optimise an individuals training.

The basic premise is that RMT is practiced over a period of weeks and months. Just like any other muscle this allows the lungs to perform better after training and it also allows the lungs to perform using less oxygen. This in turn leaves more oxygen within the body to be transported to the other muscles. (R, Lowe. 2017)

Fig. 009

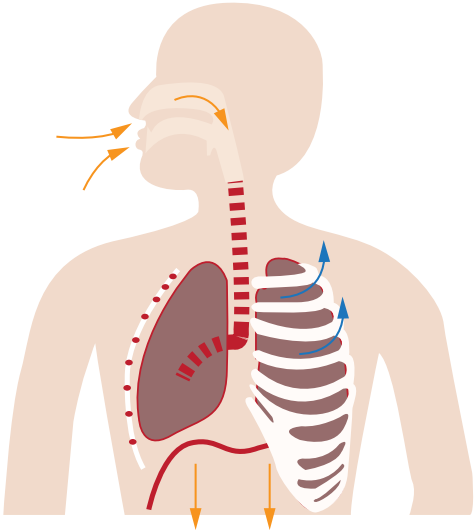


The Respiratory System



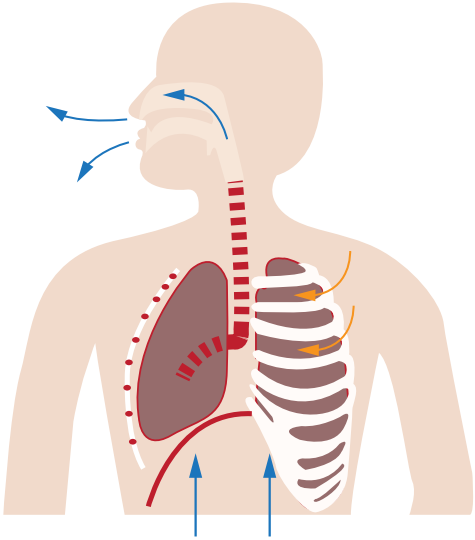
Respiratory Muscle Training (RMT) works by utilising the cardiorespiratory system. The respiratory system is a very complex system that supplies the human body with oxygen using a two part-process called respiration.

Oxygen is brought into the body through breathing, the oxygen passes down the tranchea and into the right and left bronchiole. Once the oxygen has made its way into the lungs it reaches the Alveoli. The alveoli is what supplies our body with oxygen. Using diffusion these microscopic air sacs release oxygen into our blood which is then pumped around the body with the heart. This oxygen is then used throughout the body which helps convert nutrients into useful energy for the human body to function. (K, Zimmermann. 2016)



Breathing In

Using the internal intercostal muscles that relax allows the external intercostal muscles to contract that pulls the rib cage upwards and outwards. As well as this the diaphragm pulls down in the abdominal cavity, this increases the volume in the lungs and decreases the pressure. As this happens it allows the air to pulled into the lungs.



Breathing Out

When breathing out the external intercostal muscles relax causing the internal intercostal muscles to contract. This pulls the ribs inwards and downwards. The diaphragm also relaxes and moves back upwards, this allows the lungs pressure to rise pushing the air back out of the lungs and out of the body.

Fig. 010

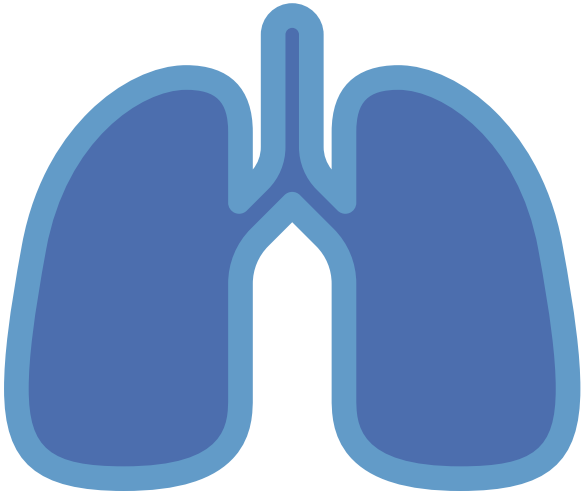
Optimising Sports Performance

Within sports, people are always looking at methods in which they can optimise their own sporting performance. Optimising sports performance can be achieved using a variety of different methods, however within this project the aim will look to improve performance by enhancing an individuals physiological make up.

Respiratory Muscle Training to Optimise Performance

Respiratory Muscle Training (RMT) can be used to train the respiratory system just like weight training within the gym can help improve strength and endurance for the external muscle groups that are visible on the human body. Resistance training is one particular method of RMT, this involves physically limiting the amount of oxygen traveling into the lungs, causing the inspiratory muscles to work harder, therefore increasing their strength. A study was conducted that asked participants to use resistance training 3 times a day for 10 weeks, the results found a 30% improvement in inspiratory strength (E. Lynne, 2015).

RMT works by firstly optimising the blood flow within the body, as well as this it also gives the users a reduces sense of respiratory and peripheral effort. This allows the user to physically feel like they are optimising their performance as well as psychologically. It works on the psychological front due to users becoming more adapted to performing with limited oxygen, so when the athlete needs to perform with the body running low on oxygen, in theory psychologically it is easier for them to cope. (McConnell, 2015)



30% improvement was found in respiratory strength after utilising resistance training for 10 weeks.

Project Brief

To design a sporting training product to aid sporting performance with a focus on respiratory muscle training that will improve lung strength and endurance for the semi-professional athlete.

User Profiling

Fig. 011/012

Rhys, 24

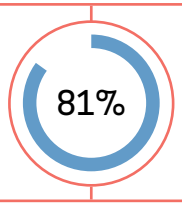
Rhys is a semi-professional tennis player living in London, UK. He trains daily and is always looking for new technologies within sport to aid his performance. When Rhys is training he is fully focused on his performance and pushing himself to his physical limit. His primarily focus is becoming a fully sponsored professional tennis player.

Emma, 26

Emma has been running marathons and representing her club for the last 6 years. Living in London she often trains within the confines of the city. She is looking to aid her sporting performance but to still fit in all of he workouts around a full-time job.

RISING PROSPERITY

Given to the name to those who are young, educated and mostly living in the UK's biggest cities.
These people are often referred to as the internet generation and are seen to frequently use new technology.
Seen to have an cosmopolitan outlook and have urban lifestyles.
Reported to spend over the average on sports and leisurewear.
(Acorn, 2017)



of people are seen to have the health benefits of sports prominent within their thoughts and the motivational benefits of visualisation fitness and health progress.
(Mintel, 2017)

Fig. 013

Ultrabreath

The Ultrabreath is an inspiratory muscle trainer. The product has been focused to improve the inspiratory muscles by using resistance training. It features two resistance adjustments that allow the user to personalise the products resistance levels for their own workout.

Strengths

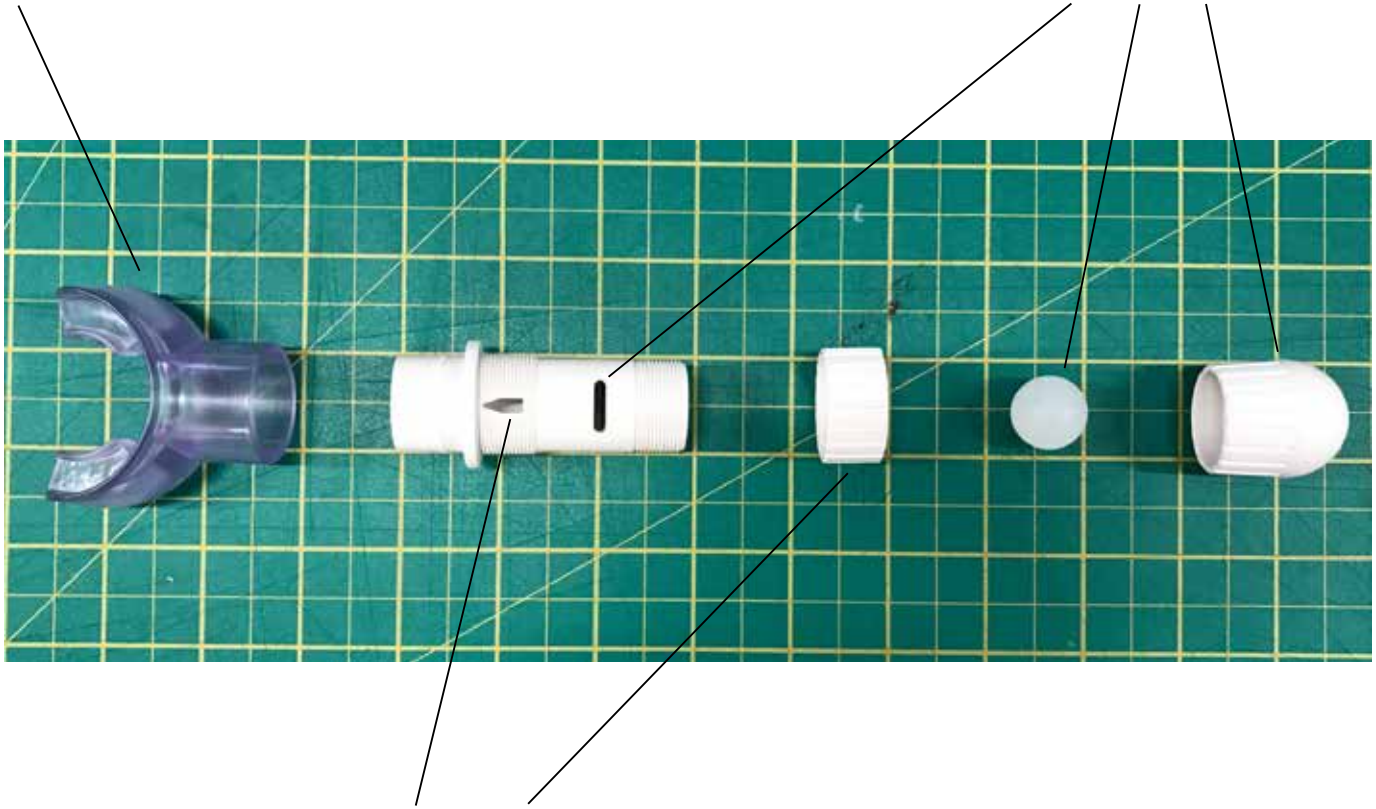
- Cheap to purchase for consumer
- Compact Design
- Easy to clean, no electronics so can be placed in dishwasher.
- Resistance can be personalised to user.

Weaknesses

- Product is very hard to read and understand
- Cheap materials equal to a very undesirable product
- No feedback to user on their improvement
- How much resistance is being applied is hard to tell.

The mouthpiece of the Ultrabreathe was designed so the user can bite down on the device using their teeth. The silicone mould has been designed so it can be easily taken off and cleaned, something vital for any breathing apparatus. Replacements can be purchased again, to solve the hygienic issues.

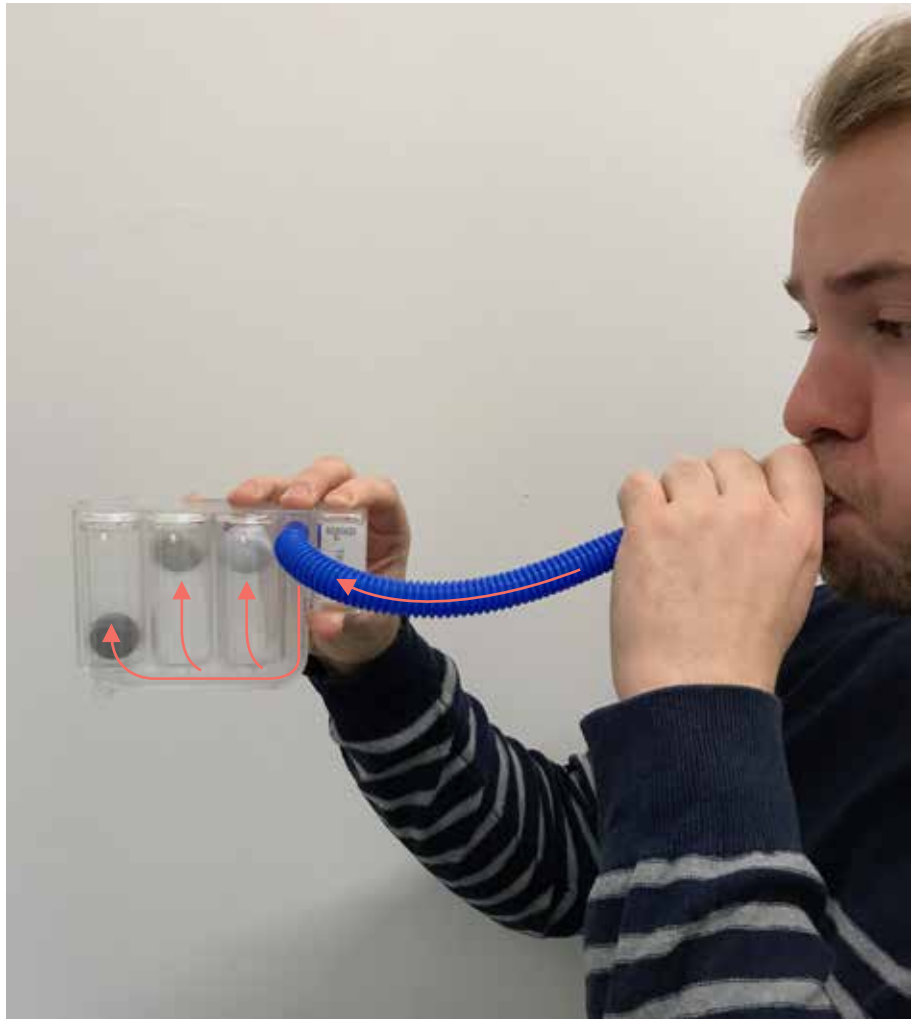
This larger opening is used in conjunction with an ABS ball and another adjustable sleeve. These parts work together to limit the amount of time taken when breathing out. If the sleeve is tighter the ball requires more outwards force to move meaning the expiratory breathe requires more force. Again this was not made clear until instructions were read.



This pentagon-shaped hole is used a long side a rotary sleeve that when adjusted can limit the amount of oxygen that is breathed in. Although this was not made clear just by looking at the product.

3-Ball Spirometer

This other respiratory trainer is called a 3-ball spirometer. This particular respiratory exercise trainer uses 3 balls as a breath indicator. As the user breaths out or in they can manipulate the balls within the device, by lifting them using their respiratory pressure. As the user does this, the respiratory lungs are pushed to their limit to lift the balls, allowing the user to strengthen their respiratory muscles.



Strengths

- Cheap to purchase for consumer
- Can change mouthpiece easily
- Visual feedback for the user using the balls as positive reward

Weaknesses

- Cheap materials equal to a very undesirable product
- Mouthpiece not comfortable
- Hard to use as a training device that would aid progression.
- Condensation build up as well as being hard to clean.

The blue PVC tube has been designed to allow it to flex and bend. The purpose of this is to allow flexibility when using the product and to allow the tube to be placed in the most natural position when in use. The rectangle to the left is within the mould to allow the mouthpiece to fit in and to allow the product to pack down into a smaller footprint.

The mouthpiece slots on to the blue tube. It can be easily changed but on such a cheap product it is hard to see this being the case. The slight lip on the design has been placed to allow users to use this to maintain grip on the device when blowing. The cleanliness of the device is a slight issue.

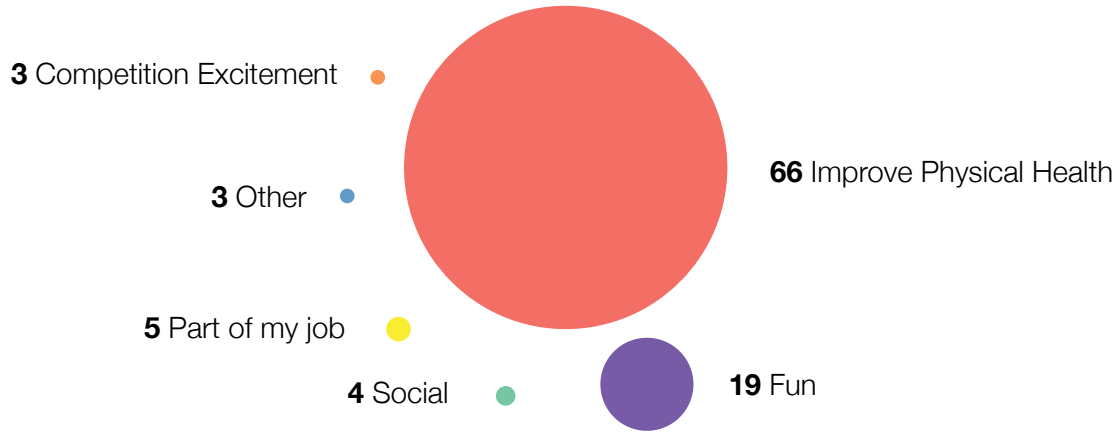
9 holes were placed where the tube slots on to the main housing for the product. This seems to be used as some sort of filter, as well as this, it seems like the design incorporates this to restrict the air flow. Increasing the resistance allows the product to increase respiratory strength of the user.

These three balls are used as the primary interactive point. As the user inhales or exhales they can lift the balls. The balls can then be used as a training product. As the users respiratory strengths increases the more balls they can lift.

Survey

A survey was constructed to help identify why people par take in physical activity and to gain an understanding within the topic area to identify design opportunities.

Factors established as to **why people take part in physical activity.**



02 out of **100**

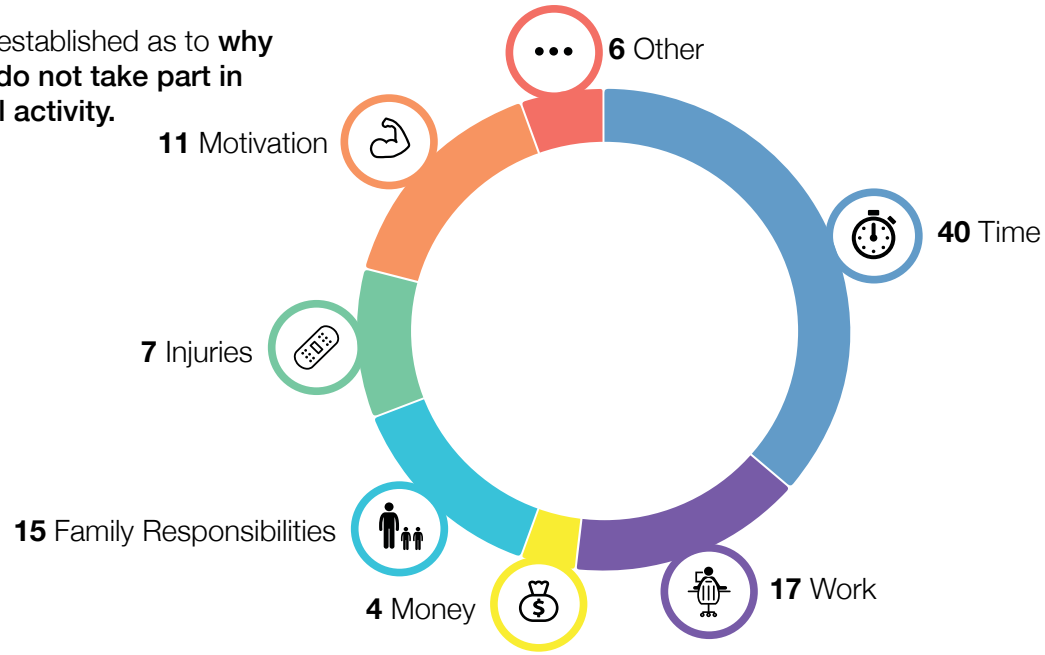
answered that they had used RMT in the past.

87 out of **100**

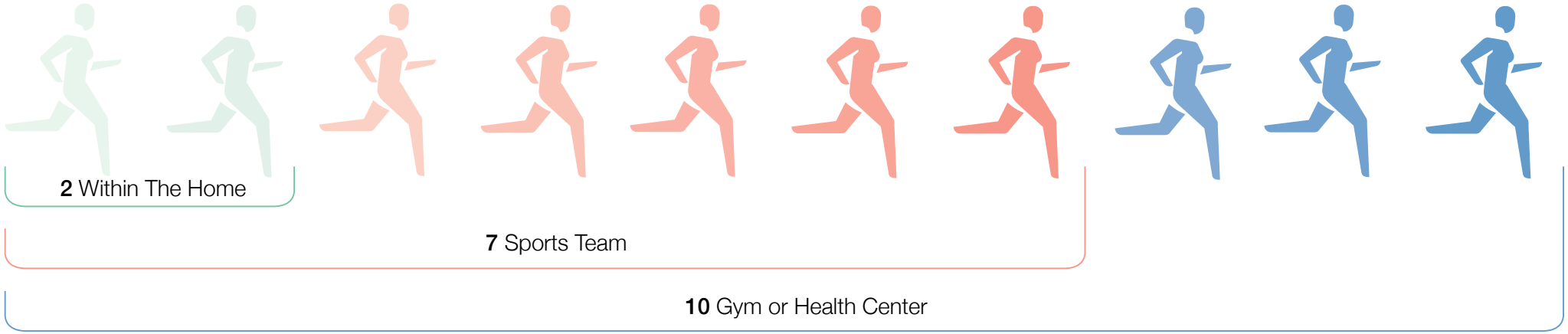
answered that they would be willing to incorporate RMT into their routine after being given a brief explanation of what RMT is and its potential benefits.

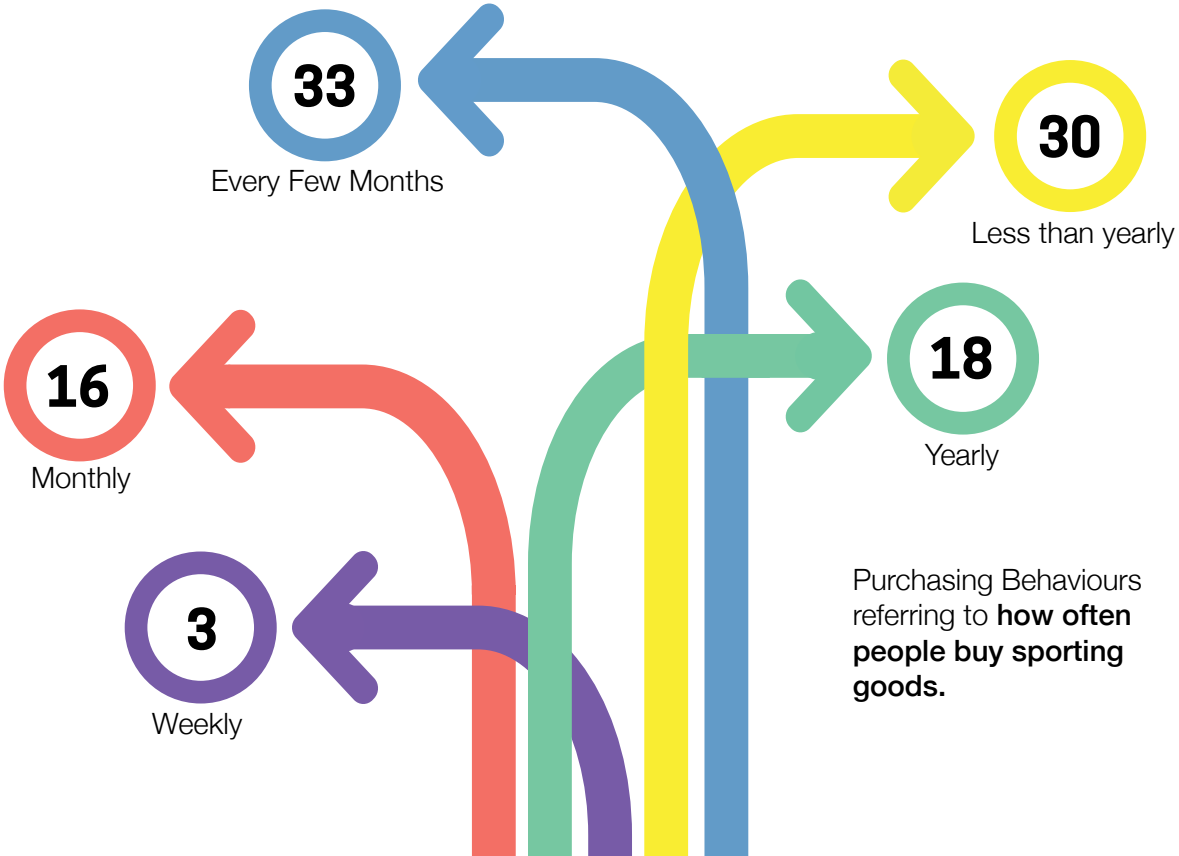
> "The biggest preventing factor for me is the cost of activities as I prefer to exercise in gyms and classes. Spare time is also a huge preventing factor for me with all of my other responsibilities in place."

Factors established as to **why people do not take part in physical activity.**



Looking at 18-34 year olds who were doing more than 4 hours of sport a week the survey was analysed to identify where these participants were taking part in physical activity.





Purchasing Behaviours referring to **how often people buy sporting goods.**

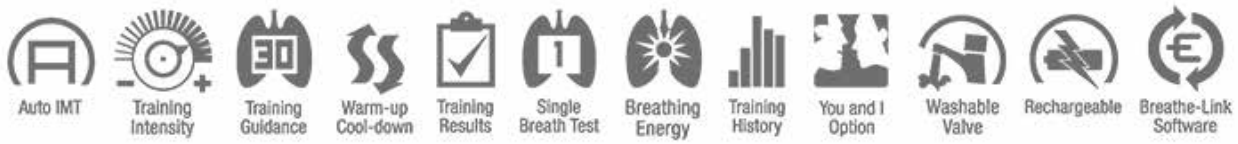
> “I’m very interested in improving my lung capacity, and as an asthmatic I feel like my training could really benefit from it. I would love to know more about the topic area.”

Tutorial Two

Tutorial two took place and the main point of discussion was looking at RMT and how a user could benefit and use this within their everyday life. The discussion was looking at when the users of the product will use this within their workouts, focusing on the environment of the products use and the exercise regimes that RMT could adapt around.

The other section of the discussion was looking at pre-existing products on the market. The Powerbreathe was spoken about a lot, discussing what the product is currently doing well and what the product is doing badly. Acting on this will allow the project outcome to feature a more suitable solution for the user.

Fig. 014



POWERbreathe

The POWERbreathe is a RMT device that has been developed to aid sporting performance and to help the treatment of breathlessness and exercise limitations. The K-Series is the third generation of the POWERbreathe, the products within the K-Series range from £299 to £499. The product has a variation of features such as the “single breath test” that measures inspiratory muscle strength and the “training history” that allows users to identify their workout trends and personal bests. (Powerbreathe, 2017)

Strengths

- Full with Inspiratory Features that can help aid users sporting performance.
- Linked with software to visualise sporting progress.
- Electronic resistance changer, allows users to simply adjust product to individuals.
- Mouthpiece can be changed for other users.

Weaknesses

- High price point
- No air flow quality control.
- Not aesthetically suited to sports market.

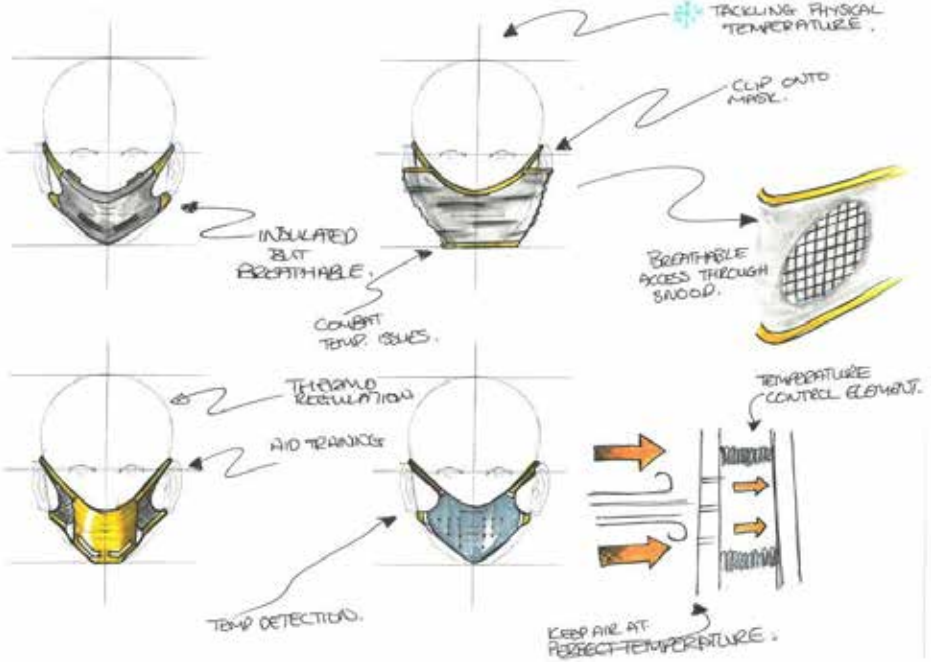
Concepts w/ Respiratory Team from Sheffield Children's Hospital

With a meeting with the Respiratory Team forthcoming at the Sheffield's Children's Hospital it was time to produce some concepts outlining the possible options for the product and the areas in which the Respiratory Muscle Training device could enhance a users respiration within sport. These concepts were then taken to the meeting and discussed in great depth.

Jane Kirkby - Paediatric Respiratory Physiologist PhD
Laurie Smith - Paediatric Respiratory Physiologist - currently doing his PhD
Nicki Barker - Advanced Paediatric Physiotherapist PhD
Dr Heather Elphick - Peadiatric Respiratory Consultant

Thermoregulation / Air Flow Temperature

These particular concepts have focused on the temperature of the air flow within respiratory muscle training. One concept features a "Snood" that can be attached on when the outdoor is low in temperature. The other looks at thermoregulation to ask the experts opinions on the topic area to see if this will be a suitable feature within the product.



Feedback

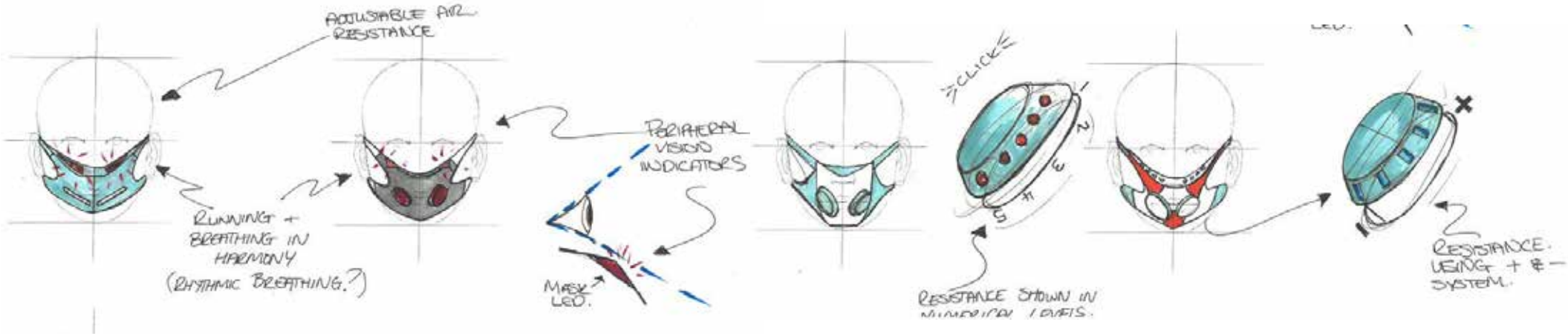
We discussed this particular concept, one thing was mentioned by Laurie Smith, was that Scandinavian athletes have a higher chance of developing asthma due to the cold air temperature. It was also mentioned that thermoregulation within air flow is important but other factors have a bigger influence on our respiratory function. The humidity of the air was also mentioned as something I should consider.

Rhythmic Breathing

This particular concept was looking at developing a training mask that can aid the users respiratory performance with the help of rhythmic breathing. When playing sports and running, breathing in sync can help aid performance greatly. These particular concepts used the idea of small LED's just outside the peripheral vision of the user to help establish a rhythm in their breathing .

Resistance Training

These concepts were shown to talk about resistance training within sports. One thing that was made clear is that within the resistance training the design is going to feature a method that will make it very clear to the user how much resistance they are supplying to themselves and how they can use resistance to improve their respiratory strength and endurance.



Feedback

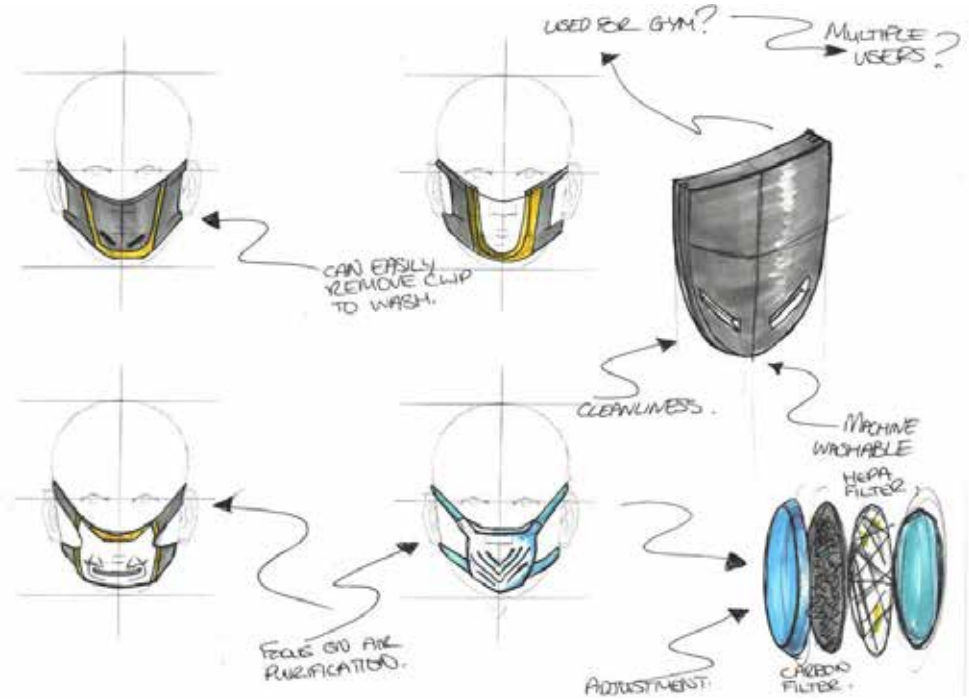
The idea of rhythmic breathing was encouraged by the experts. One thing that I was told to by consider by Jane Kirby was the gradient of the hill the user is running up. Aspects like gradient can have a big influence on the rhythm of breathing and even running for individuals so this needs to be thought about during development. They also loved the idea of "being in control" of your breathing during sports and said the idea of using audio feedback within the concept was more suitable.

Feedback

It was immediately mentioned to make sure the product is controlling the volume of air flow going into the lungs not the volume of oxygen. Another consideration was to make sure that the user is breathing correctly. It was discussed that something like a belt around the ribs could be suitable to make sure the users are using the correct muscle groups when breathing. It is very easy to breathe prominently using the throat and mouth muscles instead, that could directly reduce the respiratory muscle training.

Hygiene/Air Quality

These concepts were looking at hygiene and air quality. Filtering air quality was focused on to see if the experts felt like this was a suitable function for the product to feature and to help initiate conversation around this topic area.

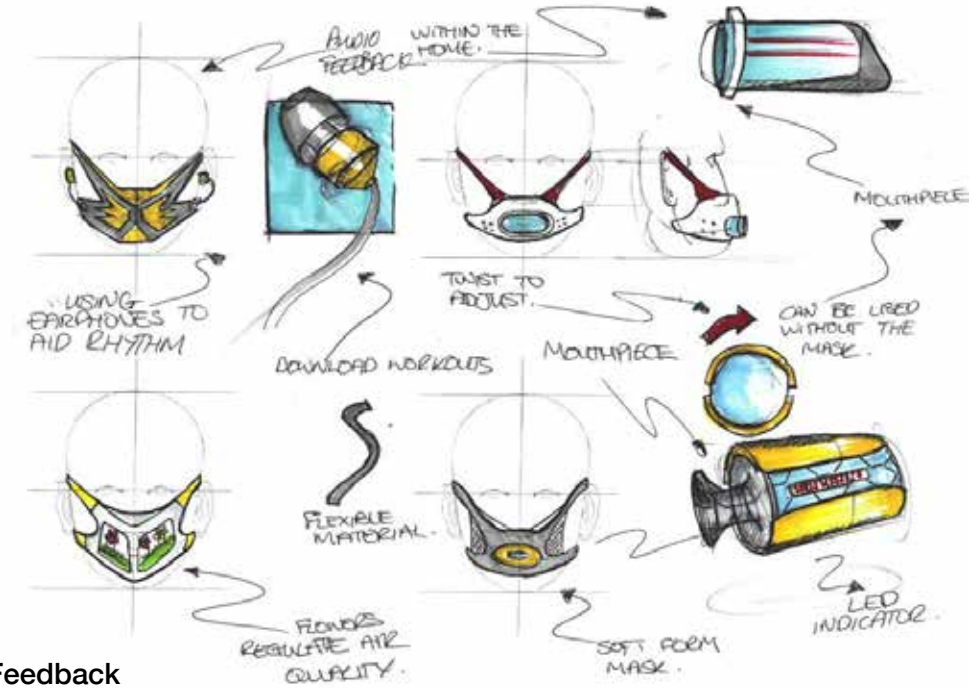


Feedback

Air Quality surrounding the user was considered an important factor when we discussed this. Nicki Barker discussed a case study with me where within certain highly polluted areas they were telling individuals to avoid playing sports due to the health problems that could occur from the higher level of flow intake.

Other

A few other concepts were design to discuss the usability of a respiratory muscle training device. These concepts featured a mouthpiece that could be removed from the mask to allow the user to use respiratory muscle training in a more secluded and homely environment.



Feedback

The first thing they mentioned is what they do is discuss methods of reducing things like lung infection and mucous on the lungs. The methods in which, they do this could be useful for the product response. They also mentioned that the product should feature a way of measuring the users progress so they can visibly see improvement.

Pollution and Sport

Air pollution within cities has become a major issue for those individuals who use city centers to exercise. This map to the right has shown certain individual cities with high levels of pollution. The numerical values are showing the period of time it is safe to exercise, before the pollution levels actually start damaging an individuals health more than the exercise is benefiting them.

Although the map to the right is showing cities, none within Europe it has emerged since the turn of 2017, London has been hit with the same problems. In January 2017, a warning was released in London to tell individuals to “reduce physical exertion, particularly outdoors.” (Forster, K. 2017)

The Breathe London Organisation advises cyclist to wear a pollution mask when cycling throughout the city to filter out some of the air. (Breathe London 2017).

According to reports by Kings College, around 9500 people die in London alone, due to the long-term exposure of air pollution. (Vaughan, A. 2015)

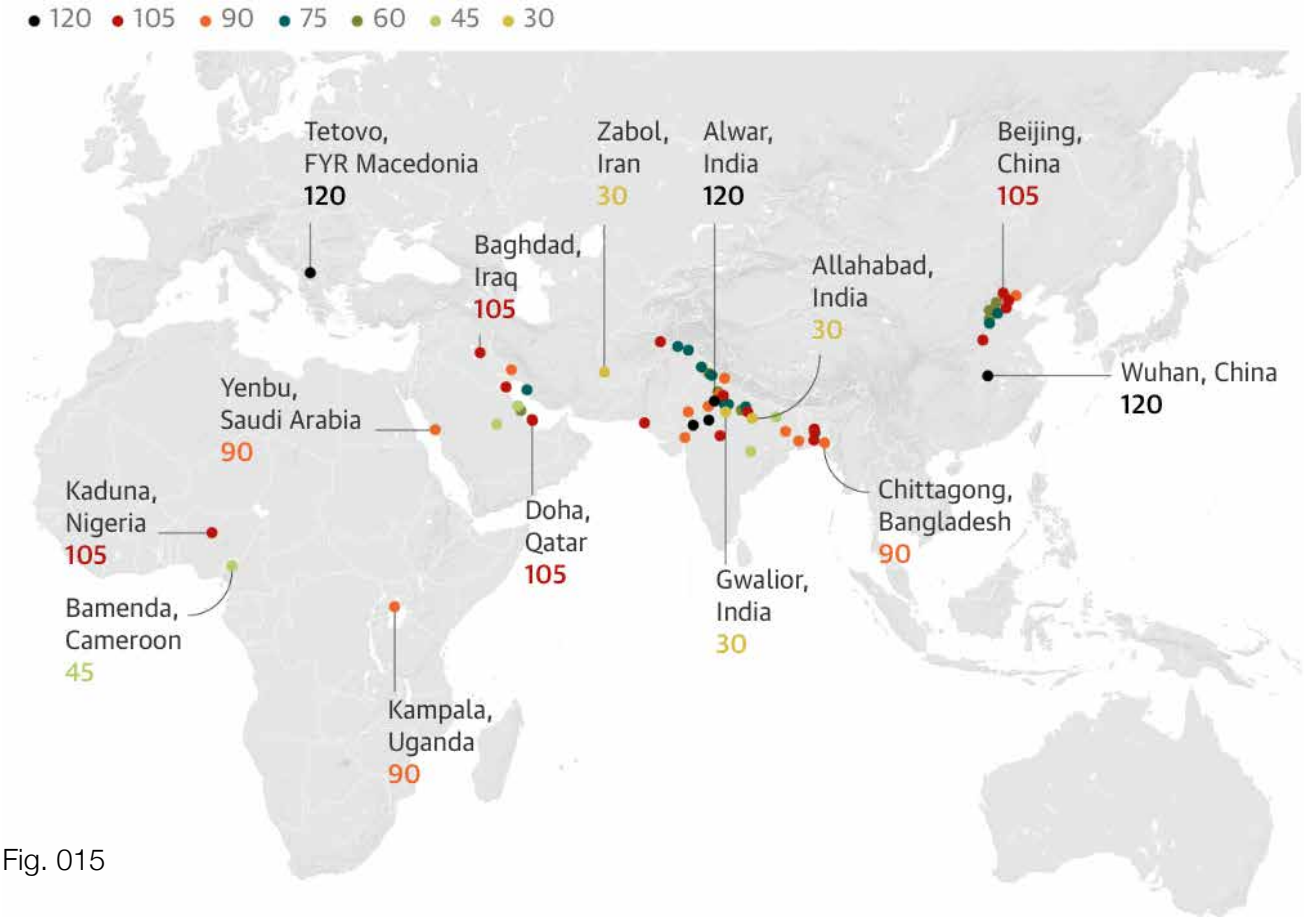
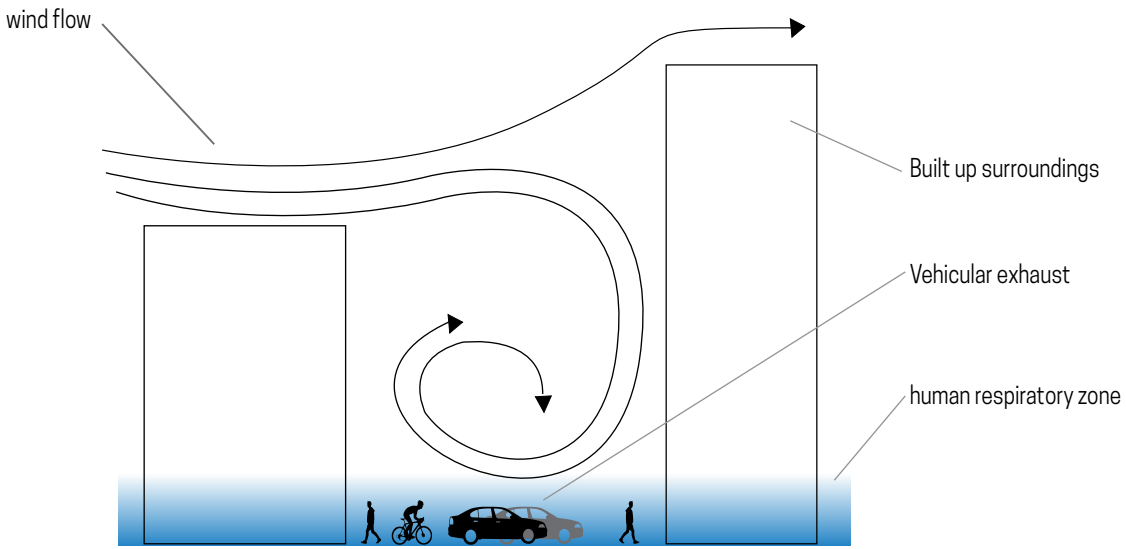


Fig. 015

Combatting Pollution in Cities

Poor air pollution within cities has given a chance for designers to establish responses to help solve this problem. A great example of this was designed by Roosegaarde, he created the “Smog Free Tower”, these large towers were created to suck in polluted air and to then filter out the smog particles. Reports suggest the device can filter out around 30,000 cubic meters of air every hour. (Linder, A. 2016)

The carbon that was then taking from the machines was compressed for 30 minutes and turned into jewelery.

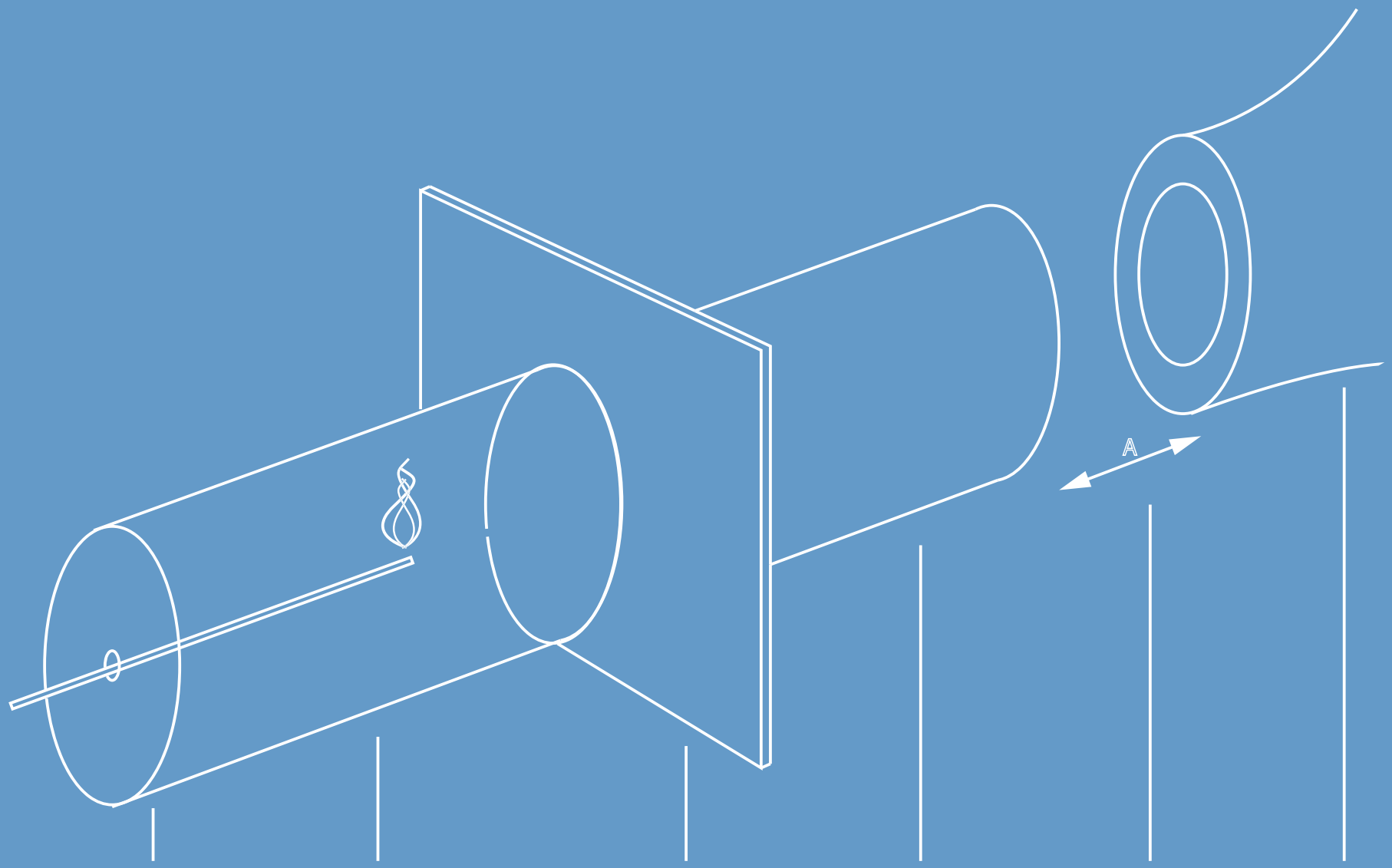


Copenhill

Copenhill is set to be completed in 2017, although the building is not directly combating air pollution it is supply homes all round Copenhagen with 99% efficiency. By the Danish architect group, Big, Copenhill has been designed to celebrate clean and renewable energy within society. To celebrate, Copenhill has been designed with a ski slope on the top and the worlds largest climbing wall down one side.
This piece of architecture has shown that with the right solutions sports can be safe anywhere even directly on top of the place where the energy is being harvested. (Coffey, H. 2016)


Fig. 016

Air Flow Test Diagram



Air Flow Test

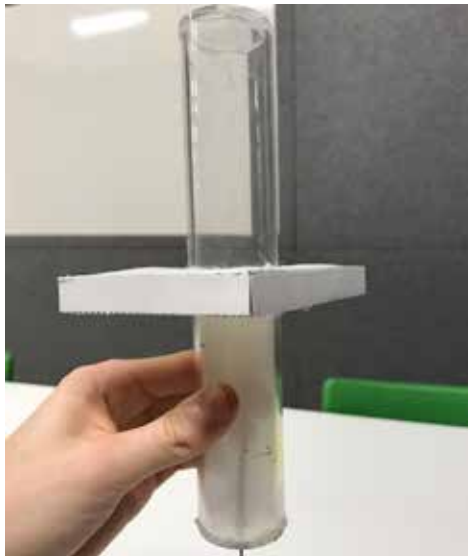
The air flow test was devised to find out the implications an air filtration system could have on the air flow within a respiratory mask. The test utilised an incense stick that was placed into air chamber one. The smoke from the incense stick was then vacuumed through the HEPA filter into air chamber two.

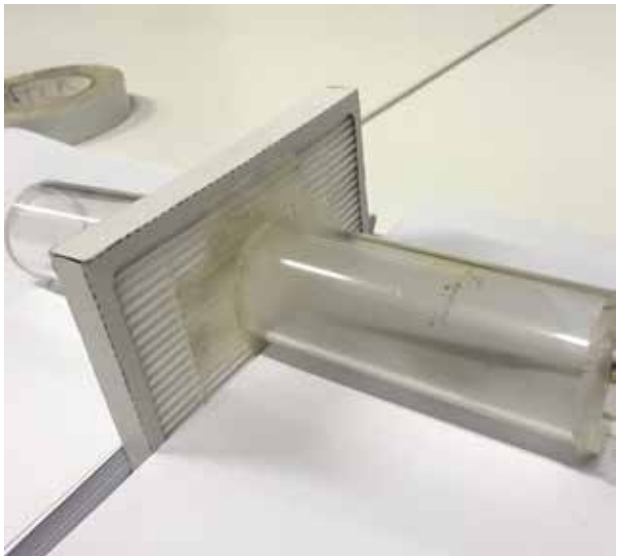
The test was created to identify if a high air flow would have an influence on the filters performance.

The hoover snout was placed at four different variable distances. If the air from air chamber one was removed and there was no smoke in air chamber two this would prove that the filter can still work at that speed of air flow.

Test Results

The HEPA filter allowed air to flow through however, the filter was adding a resistance to the air flow, within the final proposed a filter would need to be





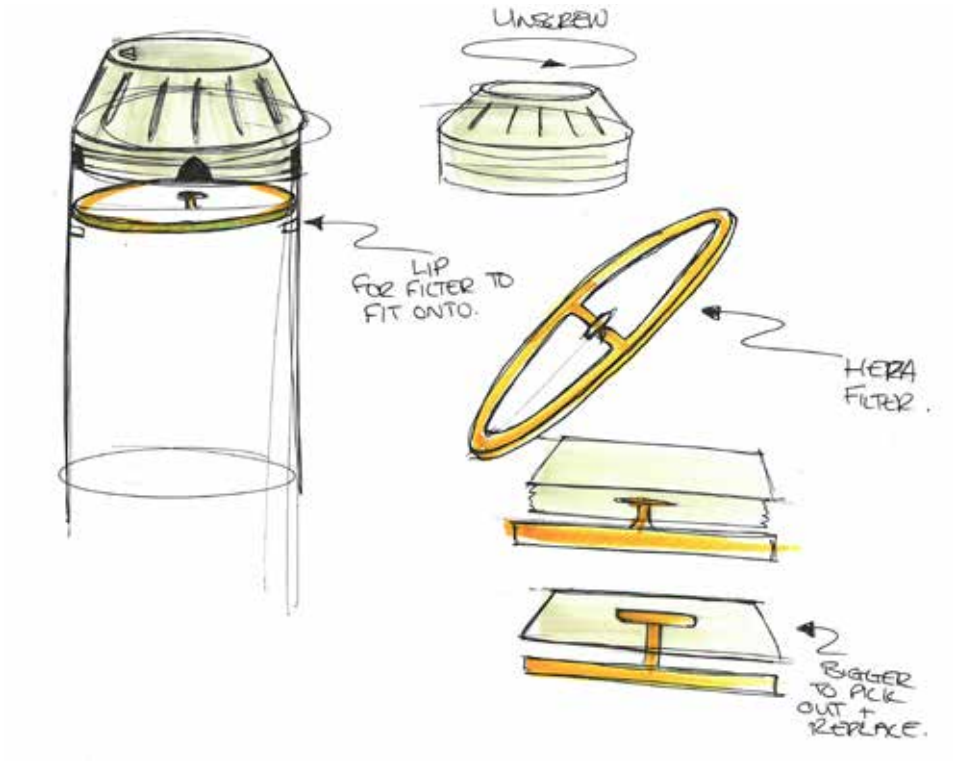
Stanford Air Filter

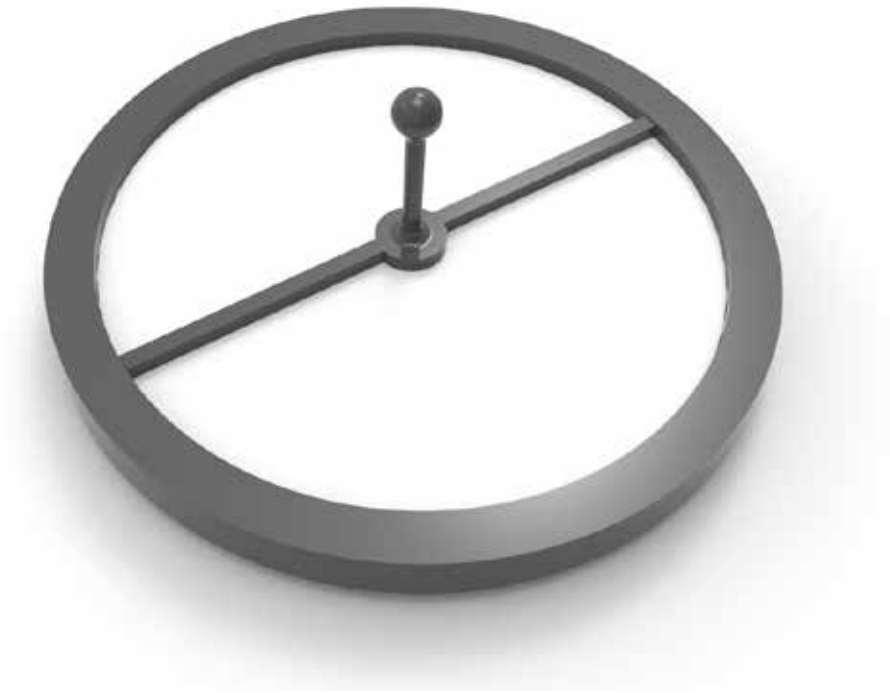
An associate professor, Yi Cui, at Standford University, USA has developed a new air filtration material. The material was discovered by the professor and his team identifying polymers that have a strong attraction to smog. The material they found was called polyacrylonitrile (PAN), a material most commonly used within surgical gloves. Using a technique called electrospinning, the process involves a liquid Polyacrylonitrile (PAN) being spun into a spider like web fibers that are a thousandth of a diameter smaller than human hair. The final material created was 70% transparent and collected 99% of the particles and it can also collect 10 times its own weight. (Carey, B. 2015)

Fig. 017

Air Filter Design

The air filter will be incorporated into the training device within the inspiratory breathe. The air filter needs to filter the air before the user can breathe in. The air filter will also require a certain amount of maintenance so changing the filter after a period of time is essential to keeping the user safe from pollution levels when par taking in exercise.





The air filter concept is looking at using a HEPA filter within the inspiratory air chamber. To change the filter a casing for the filter has been designed that allows the user to unscrew the resistance cap fully and then a top moulding has been designed to allow the user to simply pull out the old HEPA filter and replace it with the new one.

Fig. 018

Forced Vital Capacity Test

A simple test has been constructed to identify how much of an impact Respiratory Muscle Training can have on an individuals lung capacity and strength. The test uses a simple 5L bottle with a hose. The test utilises water pressure so the participant can observe how much water they push out of the upside bottle, however much is pushed out of the bottle will equal the participants Forced Vital Capacity. The test is being tested on six participants who have a similar exercise regime. Three of the participants will bring Respiratory Muscle Training into their exercise regime,once a day. After a period of time all six participants will be then tested again to identify the effects of Respiratory Muscle Training on individuals. (Participants One to three will be undergoing the RMT once a day)

Forced Vital Capacity Results

Test One

Participant One - 3.25L
Participant Two - 3.0L
Participant Three - 4.5L
Participant Four - 4.0L
Participant Five - 4.0L
Participant Six - 3.5L

Test Two (Six Weeks Later)

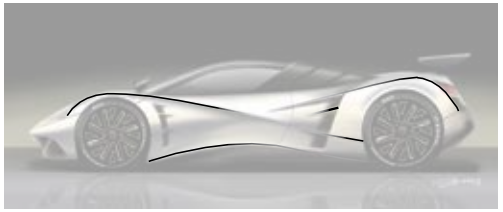
Participant One - 3.75L
Participant Two - 3.5L
Participant Three - 4.75L
Participant Four - 4.0L
Participant Five - 4.25L
Participant Six - 3.5L

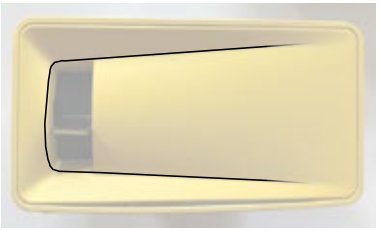
These increases in Forced Vital Capacity in participants one to three have proven that RMT can have a positive impact on an individuals lung strength.

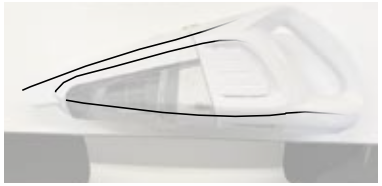
Encapsulating Motion

Encapsulating motion within automotive design is a big focus. The idea is that with clever design a stationary object can look like it has motion.

Within the final concept the aim is to give the product the feeling of by taking inspiration from products that already do this. Using sharp lines that fade into a smooth surface like the products shown to the right give the sense of motion.







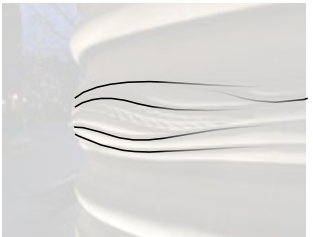


Fig. 019

Experienced Distance Runner - Semi Structured Interview

A semi-structured interview took place with an experience distance runner who suits my user profiling. This contact is essential to making sure the final concept appeals to the people it is targeted for. Nick is an experienced marathon runner who takes his running and personal fitness very seriously.

Little, Nick.

1. The first conversation we had with one another was focused on his initial thoughts on RMT. I gave him a brief introduction into what Respiratory Muscle Training is and how it can benefit an individuals sporting performance.

"I've actually briefly looked into RMT in the past through intrigue but never properly followed up on it. With some proper guidance and significant evidence for the benefit I'd be very willing to give it a go."

2. The final design solution is headed towards being a face mask over the mouth and nose that will be used when the consumer is working out. What worries would you have with wearing a mask whilst running or working out?

"I'm not too bothered about what I'd look like, though to me, the sleeker the design the better, however the comfort of the fit would be the biggest factor. I've run with gas masks before (admittedly rather different because they were for gas analysis) and they can prove uncomfortable. The comfort would have to be maintainable through the exercise as well, obviously if there is some cushioning or something then it wouldn't be pleasant if this filled with sweat, etc. One other major factor would be the ease of getting it off, in the case of an emergency or injury or something, being able to get it off very quickly would be something I'd have in the back of my mind."

3. The mask physically resists the amount of air flow accessible into the lungs to increase the demand on the lungs, the resistance can also be adjusted. This in turn improves lung strength and endurance for the user when the mask is not on. How would you feel about incorporating resistance training into your workout?

"As with Q1, it is something that I've looked into in the past. I'd be very open to training with it, but I would certainly want some guidance as to how to most effectively introduce this training method into my already busy and demanding training schedule"

4. Breathing in rhythm with running has also been proven to increase sporting performance whilst. If the mask could help the user breath in time whilst they were running do you think this is a necessity? How often, when you are running do you feel that your breathing rhythm needs to be amended?

"I very rarely feel the need to adjust my breathing rhythm and as such wouldn't really foresee myself finding that of much benefit."

5. When running what factors would you say affect your respiratory muscles the most? Fatigue, Air Temperature, Car fumes (Air pollution) or Air Humidity

I can't say that I really feel much affecting my respiratory muscles much when running. Low temperatures have some affect but that is probably most in line with a whole body effect. Air pollution is the most unpleasant, and come sometimes affect my respiratory system. Humidity isn't much of an issue for me I don't think and fatigue isn't something I ever really feel in my respiratory muscles, except after a long period of illness.

6. What methods of data collection to you currently use to record your training results?

"I use a GPS watch which I upload to my laptop and then onto Garmin Express and Strava. I also have a Fitbit which I use as a guide for tracking my heart rate/ steps/calories.".

Considerations

- Comfort
- Sweat
- Emergency Release
- Air Pollution
- What are other exercise recording devices doing?

These considerations are vital within the design to ensure the design is taking the right path and appealing to the correct consumer demographic. These considerations will be explored and developed within the project.

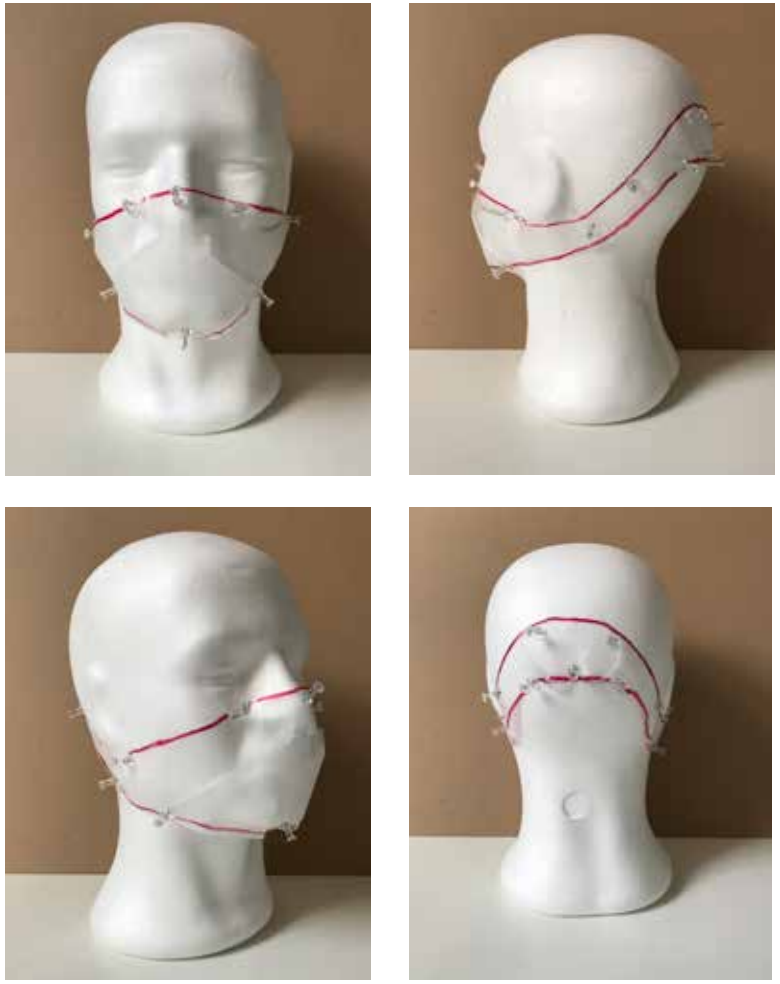
Concept One

This first concept uses a clip on method. The first image on the left shows the mask clipped off. This is to allow the product to feature an emergency clip off feature when required. This feature still needs to be resolved however. The first concept has also incorporated a bluetooth functionality which would pair to a phone app, again this feature needs to explored. The side view shows the pump button on the side of the mask so the user can self-inflate their mask to help refine the fit. The overall design has been designed to extenuate the features and to portray motion using sharp to smooth contours.

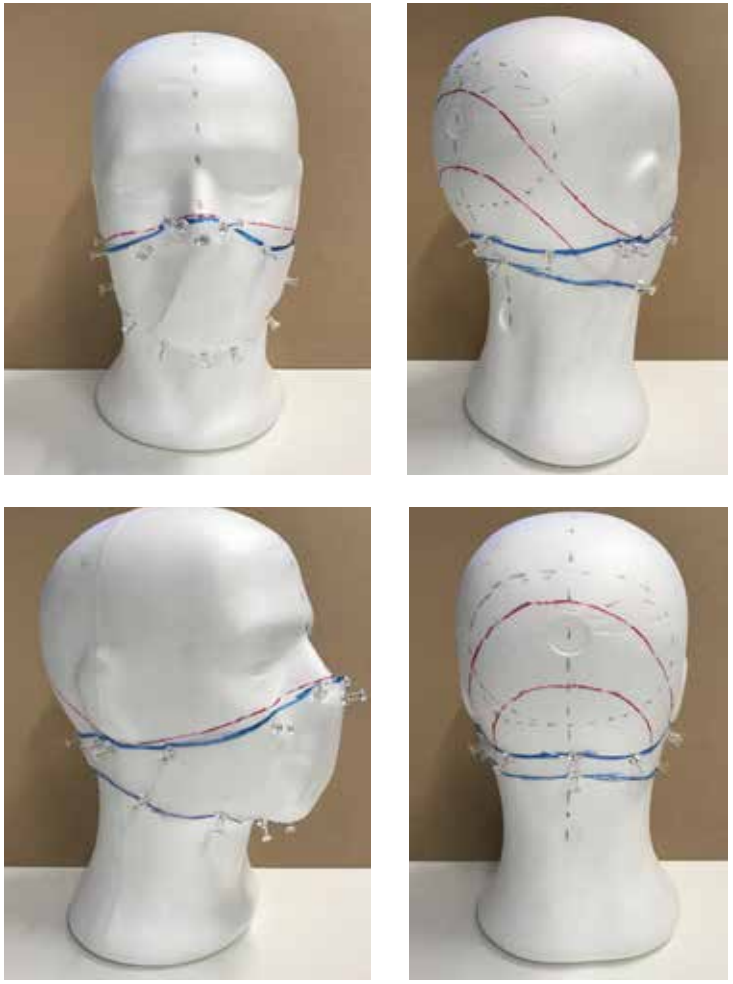
Mask Footprint

Due to the product being a very immersive product that can be visibly seen on the users face the footprint the mask has needs to be carefully considered. To do this a polystyrene head was purchased to allow guidelines using tracing paper and pins to be created. All three footprints look at different physical footprints.

Footprint One

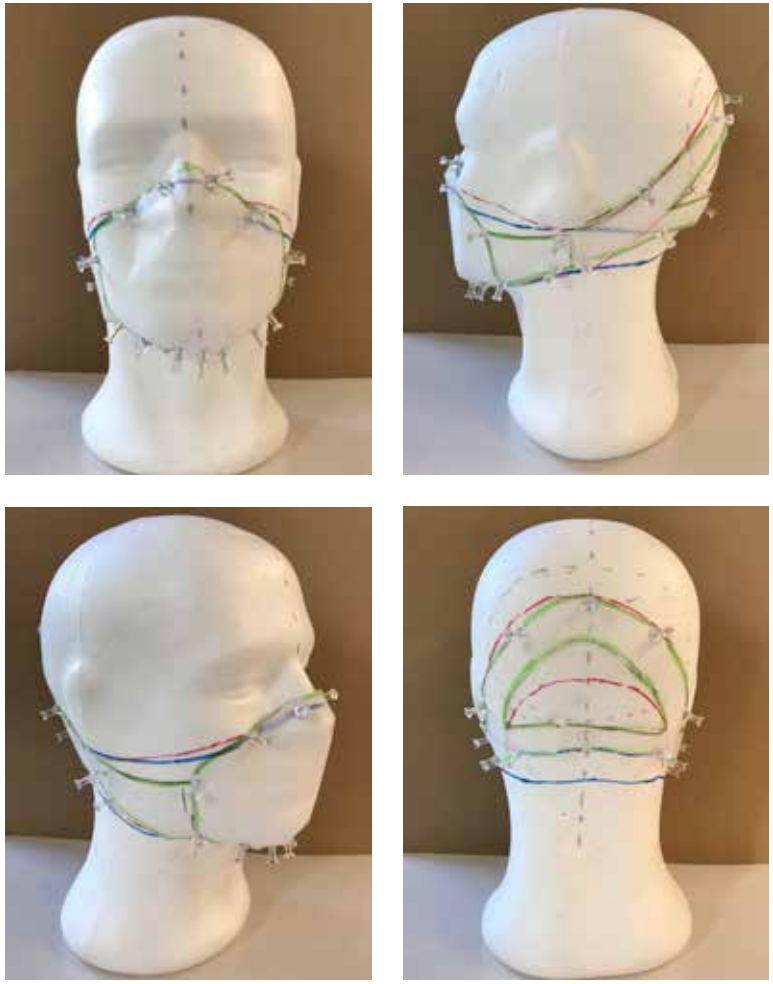


Footprint Two



Footprint

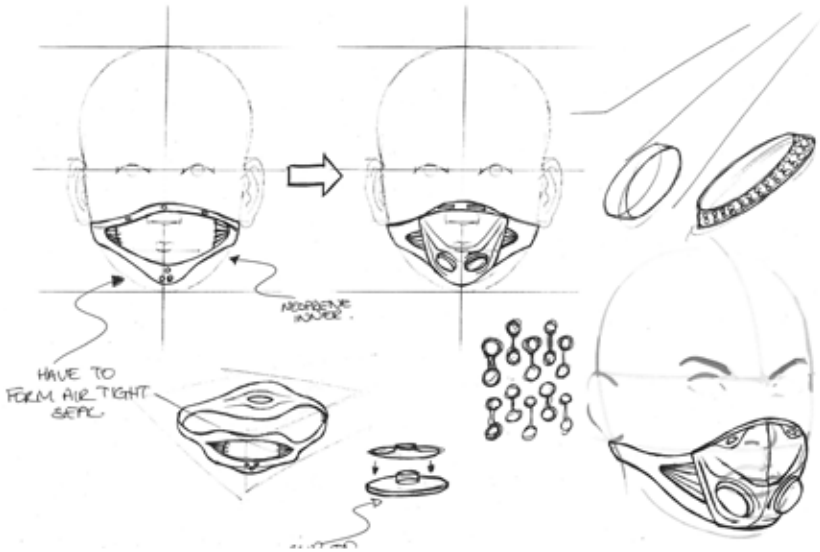
Three

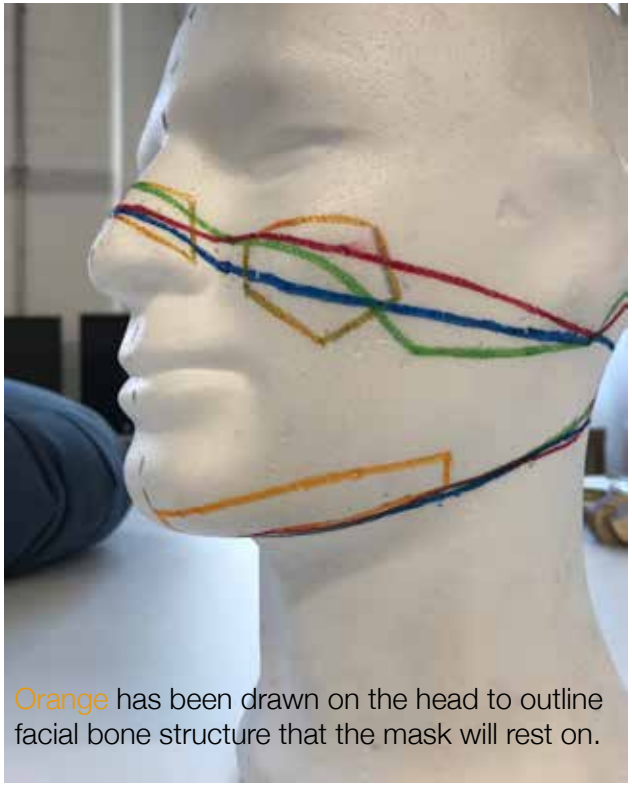


Facial Fit - Ergonomics

From the semi-structured interview with Nick it was discovered that the fit of the device will be an important factor for the user especially for when they are wearing the device for a large period of time. The mask will have to fit the face using the correct ergonomics and the correct adjustment features that will allow the mask to fit any face required.

The mask will come three sizes Small, Medium and Large, this allows the user to select a mask based on a size guide to choose the right mask for them. The facial variations for the mask will be too great to suggest a mask will be designed with a process that “one size fits all”. To test the fit of the face mask a test rig was created. Three people were asked to try on the mask who would be fit the facial size of small, medium and large.





Orange has been drawn on the head to outline facial bone structure that the mask will rest on.

Small

Medium

Large

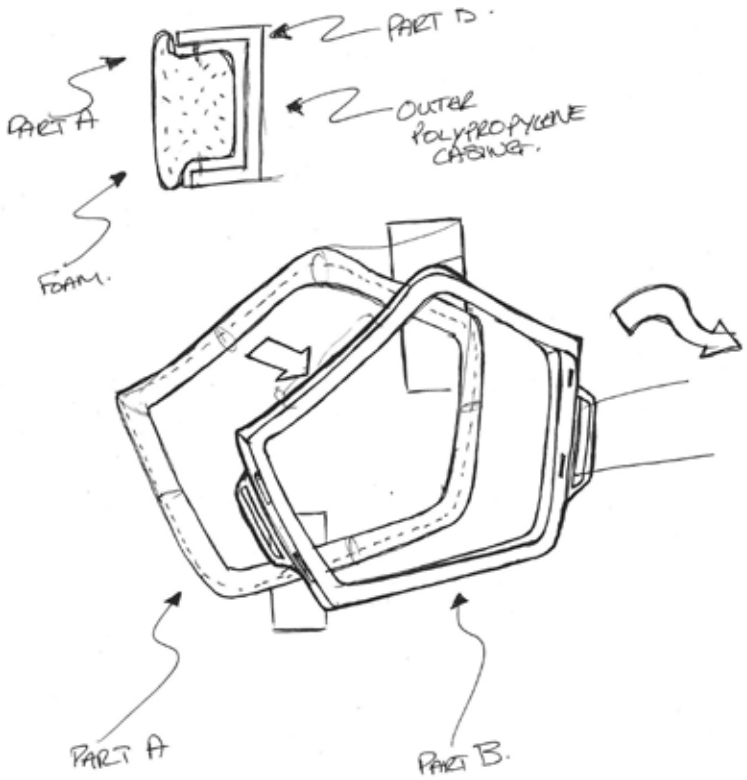
Facial Fit - Memory Foam

After the user has selected their size from using a size guide of small, medium and large, the mask will need to feature a method that will allow the user to fine tune the fit of the mask for themselves.

Memory foam, most commonly used within mattresses. Memory foam works by reacting to body height. Once the body heat has warmed the polyurethane foam starts to mould to the body.

Memory foam however reduces the air circulation around the body, this means the body temperature typically rises. This is perfect for the use within mattresses keeping the user warm however with increasing temperature on a sports product this could cause some issues with regards to sweat and over heating. (Slater, B. 2017)

Fig. 020



Facial Fit - Air Pump

Fig. 021

Fig. 023

The Reebok Instapump and the Soloman Icon Ski Helmet have one thing in common, they both use air and a pump to give their users a tailored fit when they are wearing their products. They feature a small finger pump in which the use repeatedly presses which allows air to fill certain pockets. The user uses the sense of feel to understand when the product is fitting them at the optimal point.

Using this process within the design would allow the user to fine tune their fit and then adjust this in future scenarios using a release air valve.

The mask being fine tuned to fit the user means like previously stated it should fit the user on a personal level. Another method of achieving this has taken inspiration from chemical reactions. Tyres are re-inflated using a high density foam called Tyre Sealant Foam. This foam is sprayed into the tires in emergencies once they have been punctured. The foam uses pressure to fill the inside of a car tyre and this idea could be replicated within the product to help users fine tune the mask to fit their face.

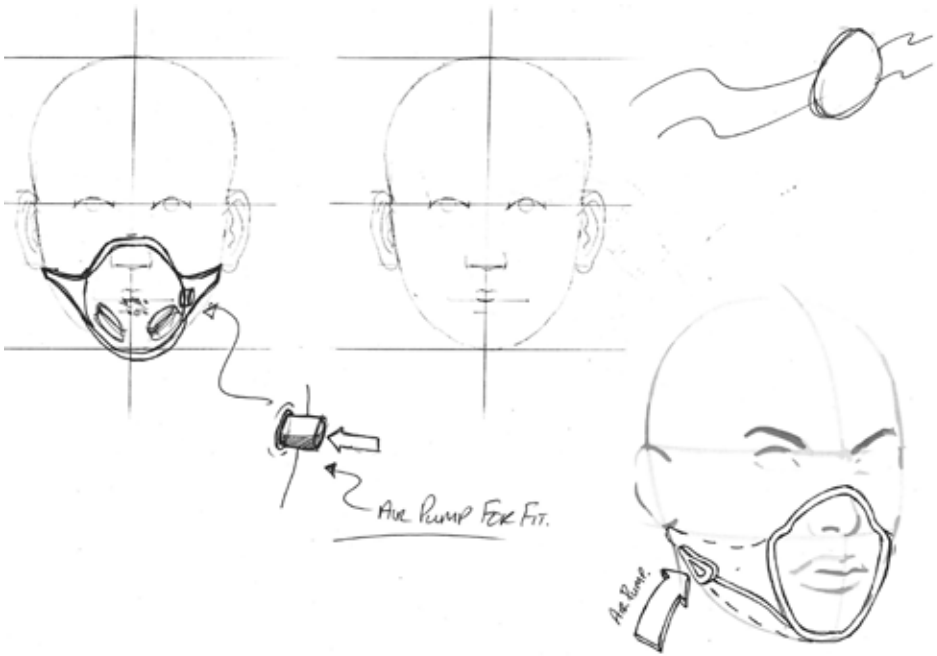
The issue with this however is that once the sealant foam has been placed within the mask the user will have trouble adapting the mask if any physical changes occur for the user (such as weight loss or weight gain).

Fig. 022

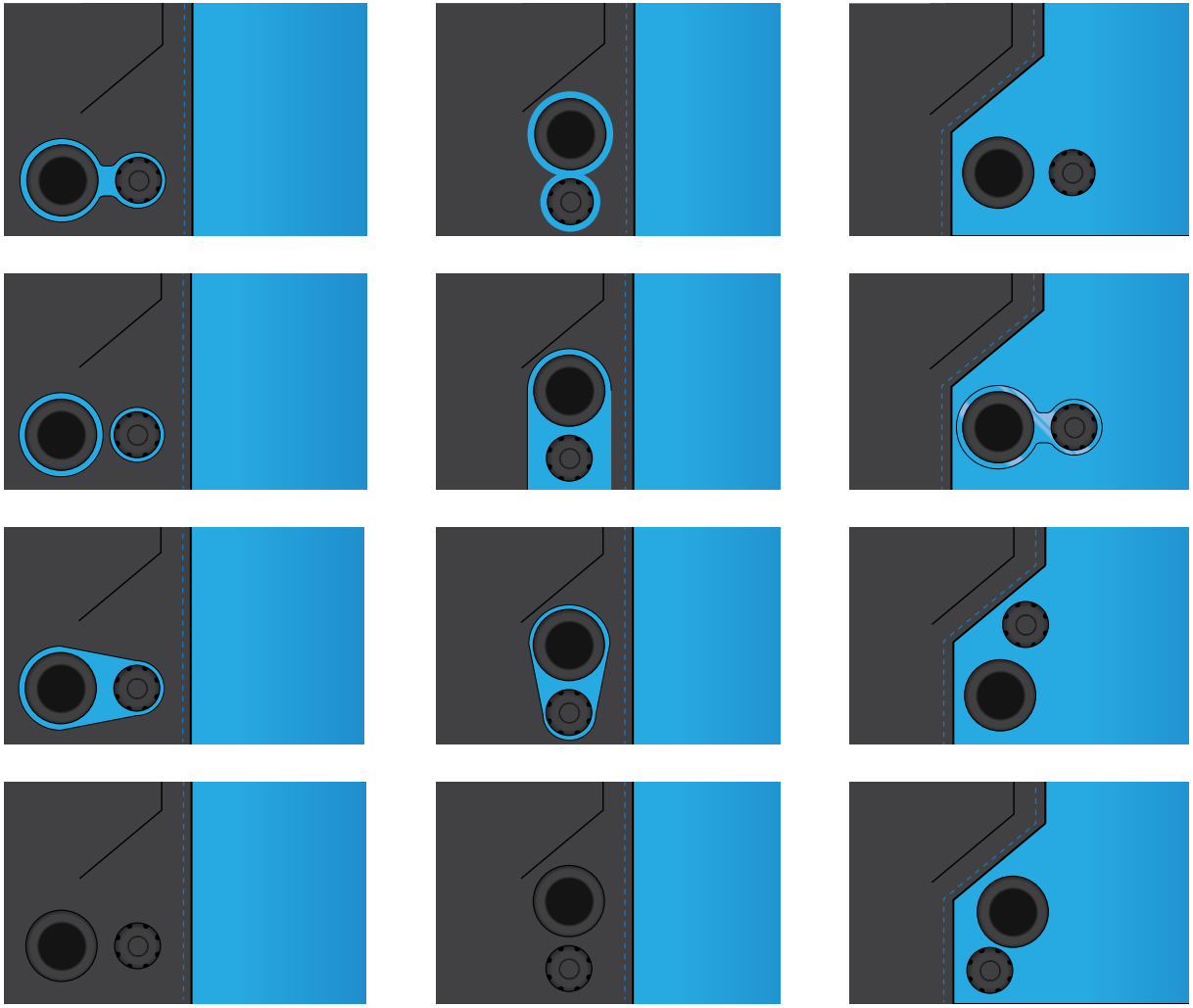
Air Pump Fit

The air pump fit will be used to allow the mask to fit to the finer facial differences between users. The illustration to the right outlines where on the mask the air pump will increase and decrease in volume. These areas were visualised using the facial areas where there is least bone structure, such as chin and cheek bones. The air pump will also help create a seal within the mask.

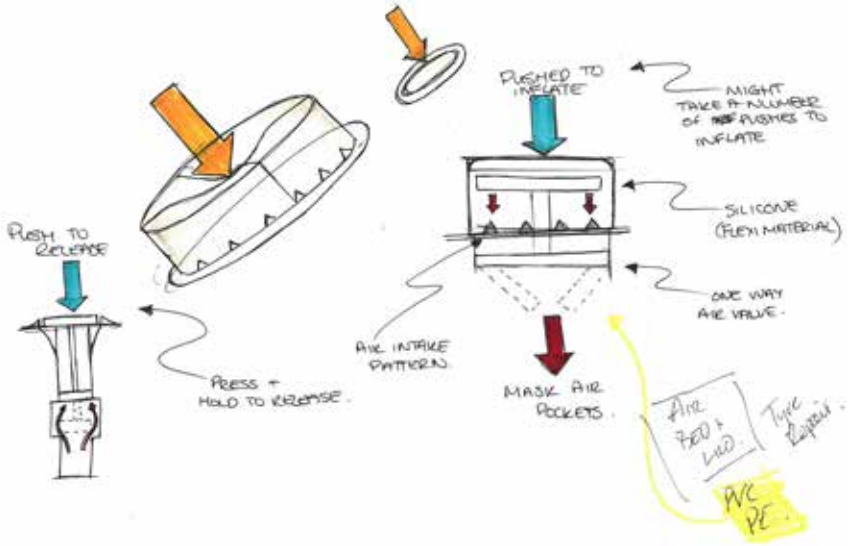
The pump will fill a polypropylene insert within the mask and will pumped using a polurethane pump. Next to the pump will be an ABS valve that when pushed will release air just like a bike pump.



Air Pump Layout

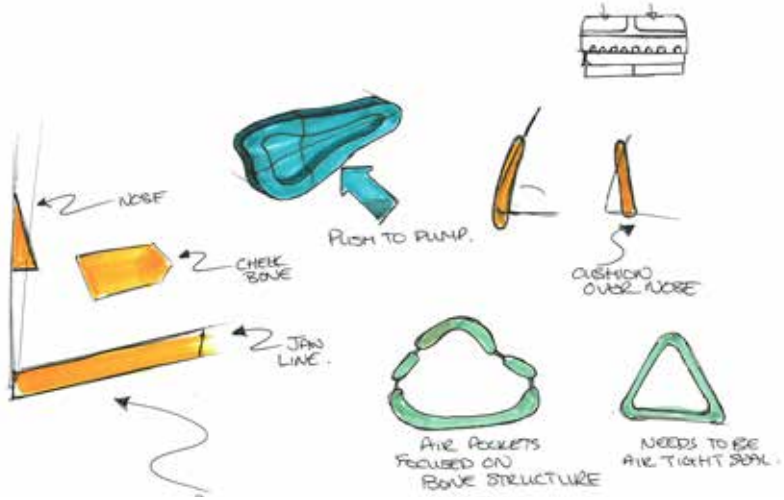


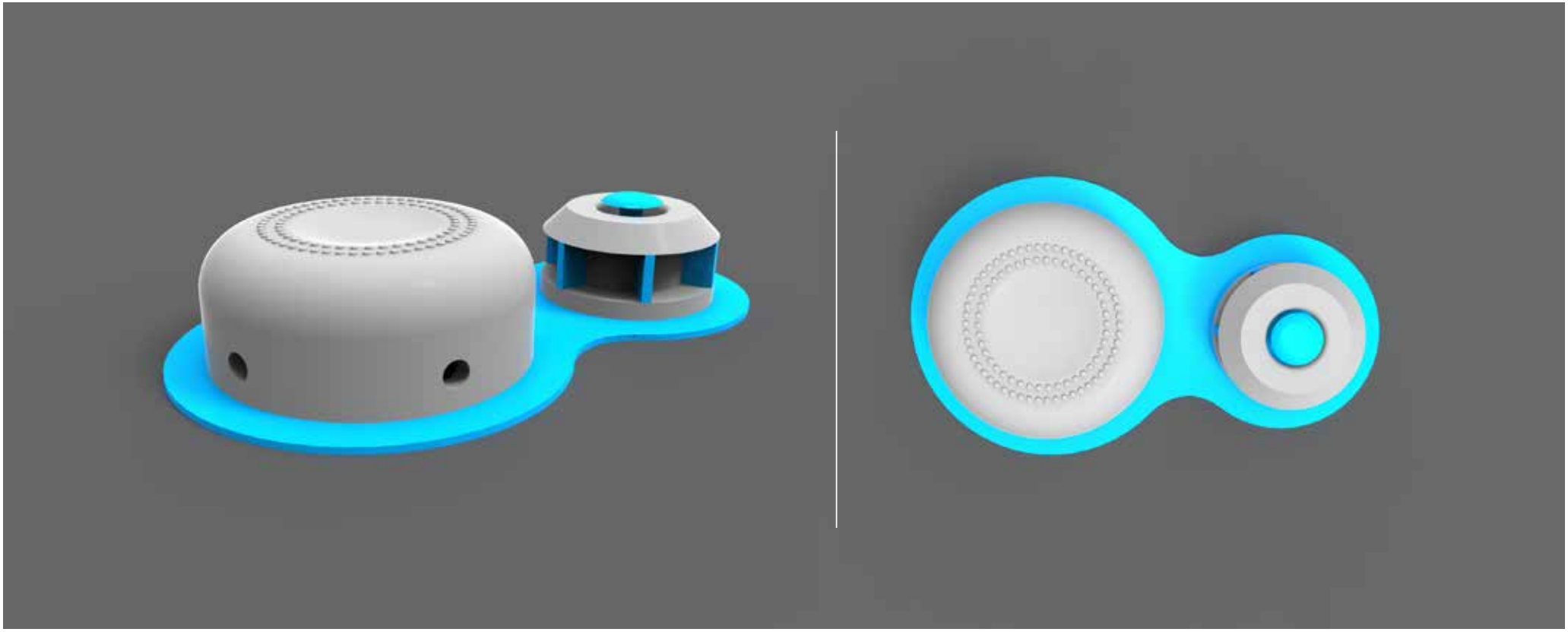
Although the air pump location will have to be tested the layout is still an important aspect to the design. The pump and valve will need to work coherently together. The grey to the left on the illustrations shows the neoprene and the blue is showing the nylon elastic straps. The decision was made to use the top left design



Air Pump Development

This air pump concept was shown at the design freeze. The air pump uses a polyeurethane cover and then pumps using a valve system, similar to that seen on bike pumps. This pump will push air into the internals of the mask to help form a seal and to allow the user to have a perfect fitting product. The valve that is featured will be manufactured from an ABS, the two three parts work in conjunction with each other. Once the blue button is pressed on the top air is allowed to escape around the button so the user can release the air from the mask before taking off.

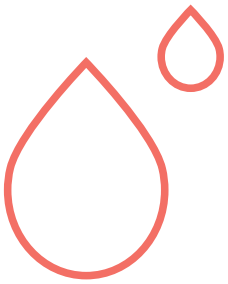




Facial Fit - Sweat

A material needs to be carefully picked out to combat sweat. Sweat can be a big inconvenience and can really affect the users performance if a large build up of sweat is present. The material chosen that is in contact with the skin and the sweat will have to use a process called wicking. Wicking refers to the ability of that fabric to move moisture away from the body and the fabric itself. This can help keep the body dry and cool even when the person sweats from exertion. (CoolHikingGear, 2015).

A wicking fabric means that the material is filled with tiny capillaries that are large enough to pull away moisture, like sweat away from the skin. It is imperative that the design features a material that is contact with the skin that will achieve the wicking process.



Natural Options

Cotton

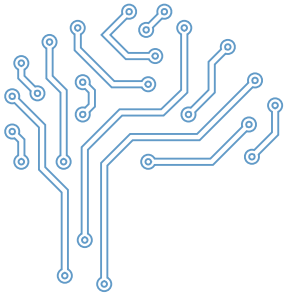
Cotton is one of the most breathable fabrics and offers some air flow for drying out dampness. Cotton absorbs rather than repels water forcing swear to sit on your skin rather than be removed.

Bamboo

Bamboo is a high quality, absorbent and breathable material. It is also a hygienic solution with resistance to odor, mold and bacteria even after multiple washings. Transfers sweat away from the body keeping the consumer drier for longer.

Linen

Linen is a natural fiber that is lightweight, breathable and absorbent. Due to the material properties linen does not cling to the surface of the skin allowing the user to remain cooler.



Synthetic Options

Polyester

Polyester is water resistant fabric and is very durable. However, polyester will not be the best solution for this task due to it letting moisture sit on your skin rather than absorbing it.

Rayon

Rayon is a fabric that is very lightweight and it does not trap heat. Again, like polyester it does not absorb sweat well and lets sweat sit on the skin so it is not a suitable solution for the heavy sweaters.

Lycra/Cotton Blend

A blend of lycra and cotton is used within water repellent clothing a lot however just like the rest of the synthetic options it does not remove the sweat from the surface of the users skin.

Fig. 024

Bamboo Fabric

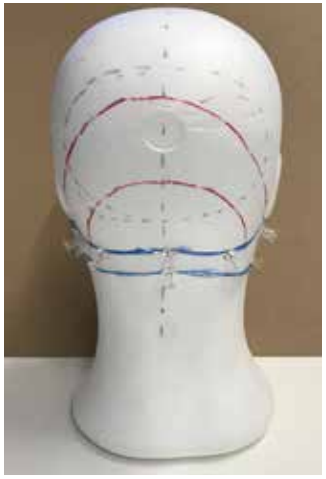
Bamboo Fabric has been chosen to be the material that will be in direct contact with the users face and the sweat build up. The fabric has been chosen from a number of different potential options however, bamboo fabric has properties that benefit the product more than any other.

Properties

- Thermo-control, breathable and can perform in all temperatures.
- Antibacterial, bacteria does not live well within bamboo fabric, results in an odour-less material.
- Moisture wicking, absorbs moisture away from the skin, keeping user drier for longer.
- Soft, a very soft and user friendly material perfect for skin-to-material scenarios.

Rear Fit

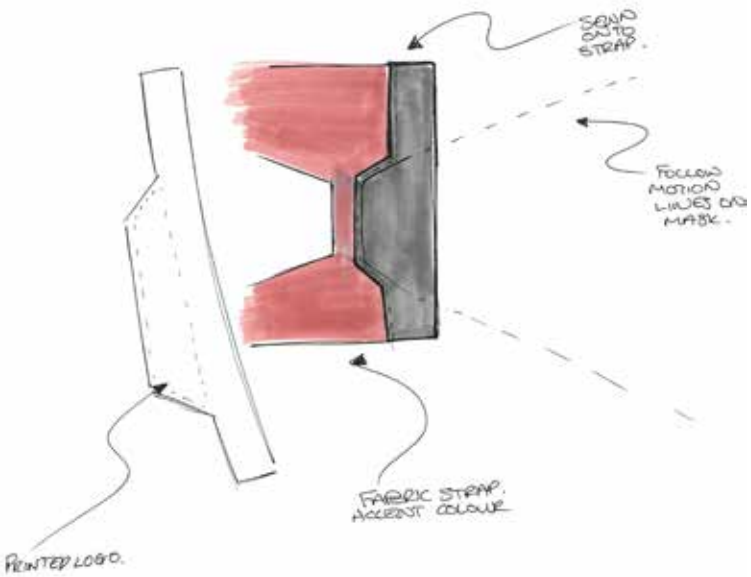
Singular High Strap



Singular Low Strap

Split Bi-Strap

A series of different straps were explored and developed to identify the perfect strap for the mask to attach to the user. The three straps to the left where done to observe where the straps would sit on the back of the persons head. A number of aspects need to be considered before the strap is fully developed. The strap needs to be suitable for both of the sexes, it needs to use as little material as possible to avoid sweat build up and discomfort, it also should be very secure, a person should be able to wear the mask for a long period of time without any discomfort or issues with the fit. Another consideration that needs to be looked into is the method in which the user selects the right fit for their face.



Rear Fit - Testing

1 The rear straps were tested by creating a framework model of the design and using some straps with a Velcro concept. The straps on the first model appeared to wrap around the users head and sat too low on the participants head. The red dashed line above shows the position in which the strap should be sitting.

2 The second set of straps was better but still needed to be adjusted to suit the users head. The strap was too thick around the bottom of the ear causing irritation for the user.

3 The third set of straps used a different fabric pattern that allowed the straps to follow the users head curve a little better. This fabric pattern was seen as the best solution to fit the users head.

Rear Fit Development

On the market today their is a vast amount of products that sit on a users face or head and require two straps to fit the user. To understand how other products fit users some market research was done to find consumer products that use an adjustable head strap

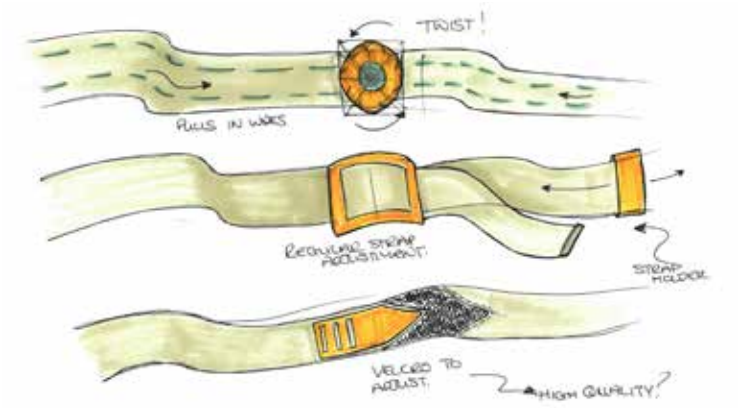


Fig. 025

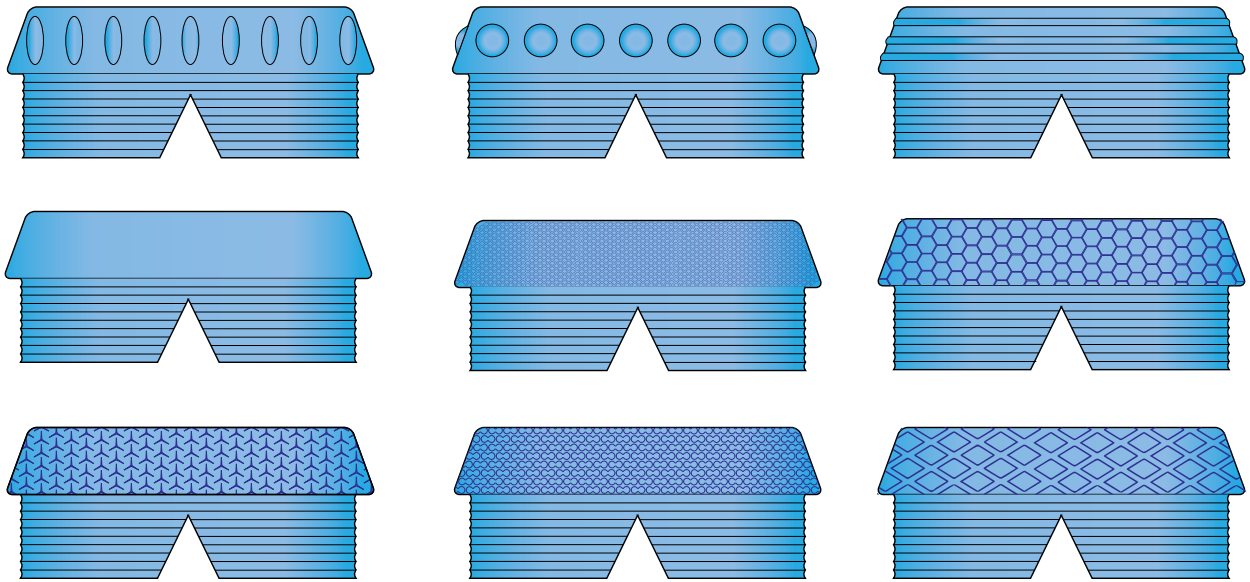
Fig. 026

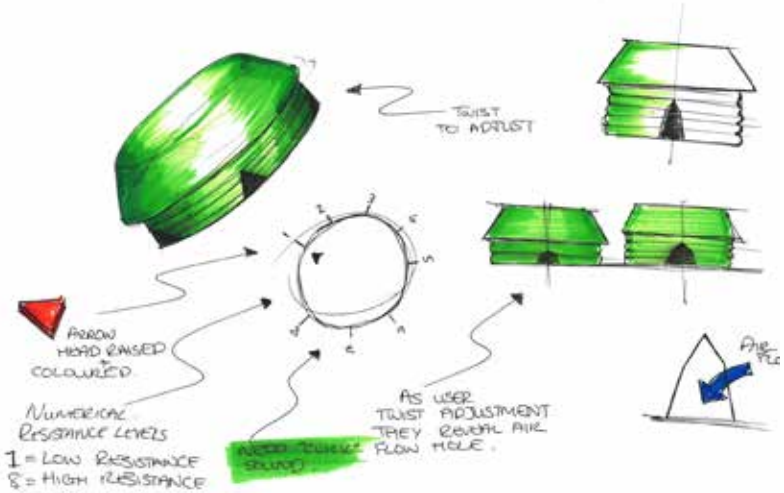
Rear Fit Development

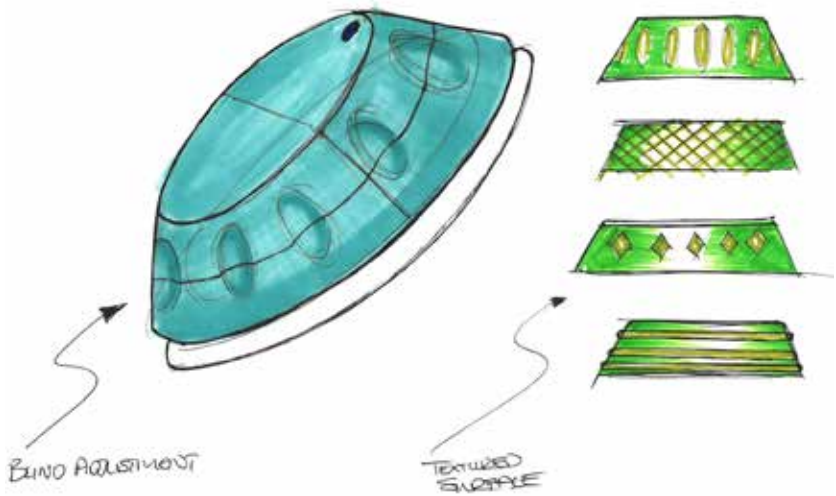
Rather than having a mechanical operation to tighten the mask the back head strap will use two nylon elastic straps that will have a sewn backed velcro. The velcro will allow the user to adjust the straps to a correct fit for the user.

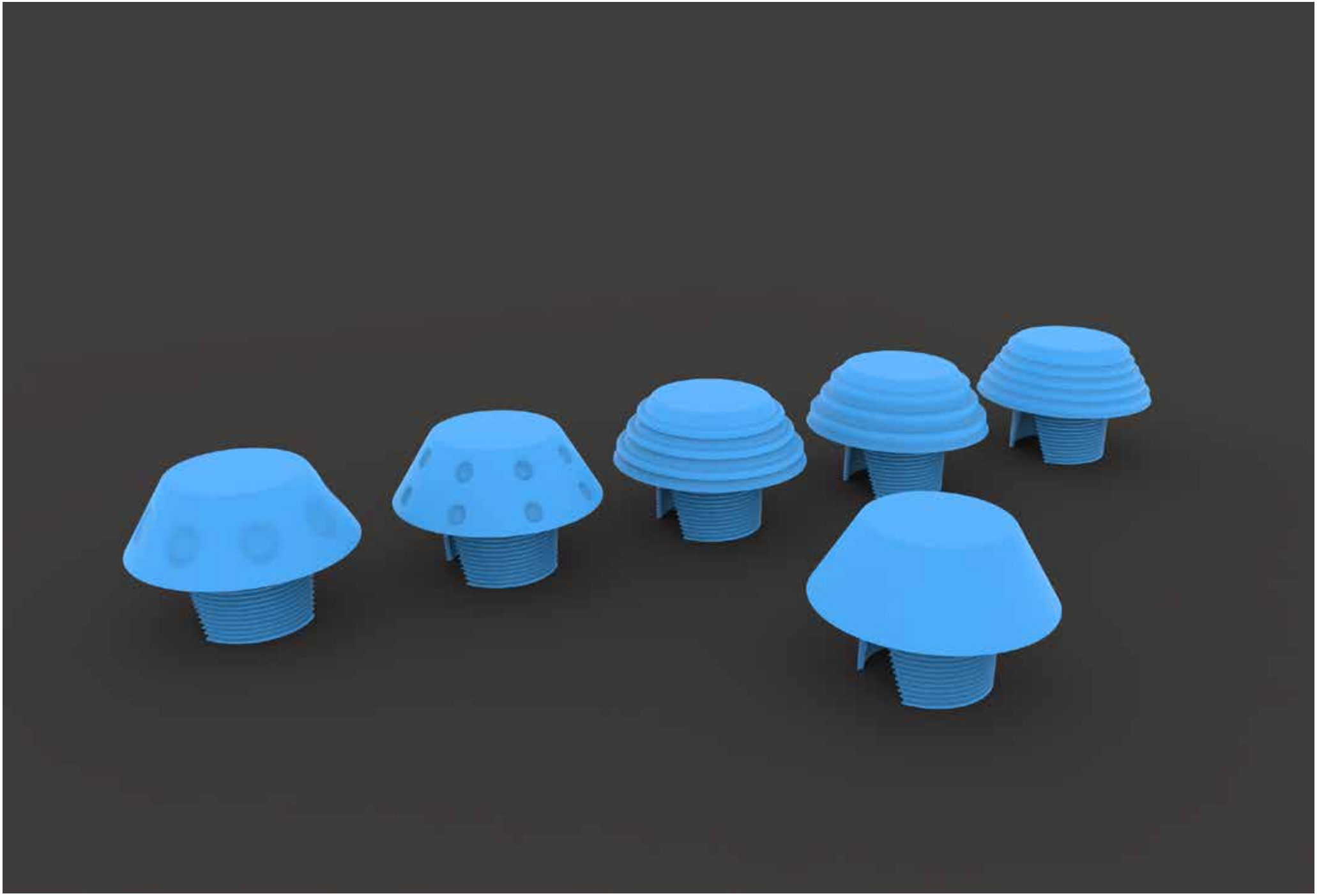
Resistance Feature

One of the main features within the product will be the air flow resistance features. The mask will feature two resistance caps that will allow the user to adjust the amount of air flow accessible to the user whilst they are taking part in exercise. This limited air flow creates a resistance and in turns requires the respiratory muscles to work harder. After a period of using resistance training it has been found that this can allow users to perform exercises using less air flow, optimising their performance.









Blind Adjustment

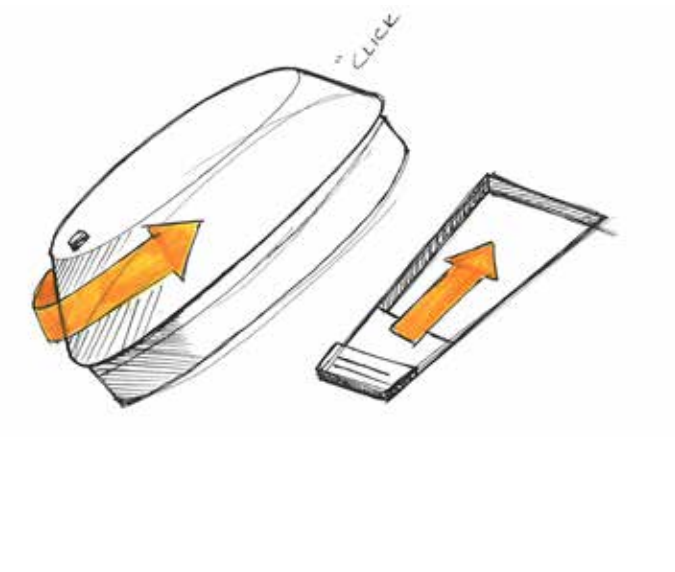


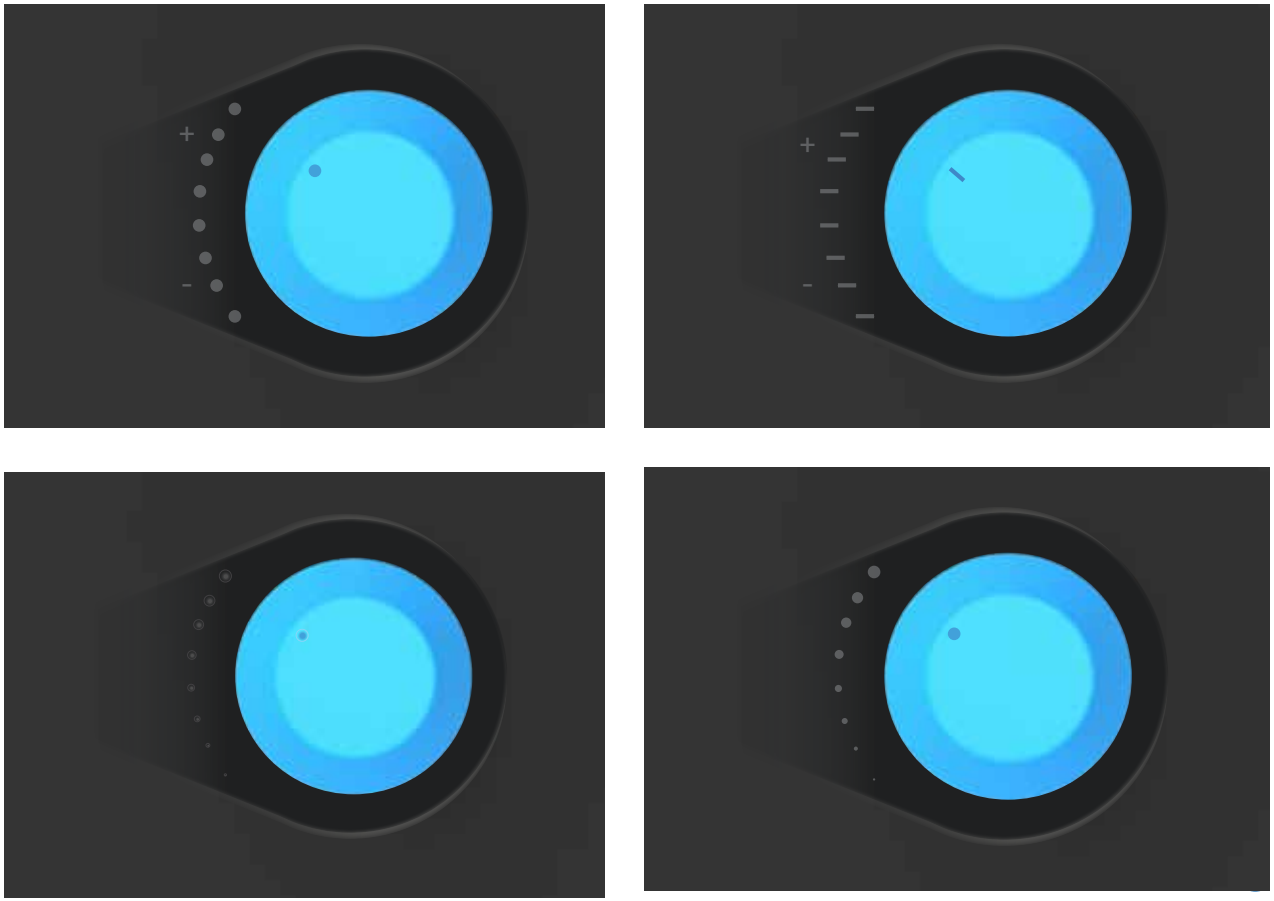

This test was created to test the best way for a user to adjust their resistance caps. All participants were asked to follow an adjustment test. For each cap they were asked to adjust the caps to adjustment 4, then to 2, then up to 6 and back to 0. The cap on the left uses no feedback for the user, the middle used a physical feedback which clicked after adjustment went up and down, the last adjustment used an audio feedback in which a sound was played as adjustments went up and down.

The results were decided that a physical feedback was the best adjustment. All participants picked the physical feedback as the best way to adjust the caps. This will be taken through and implemented into the resistant caps.

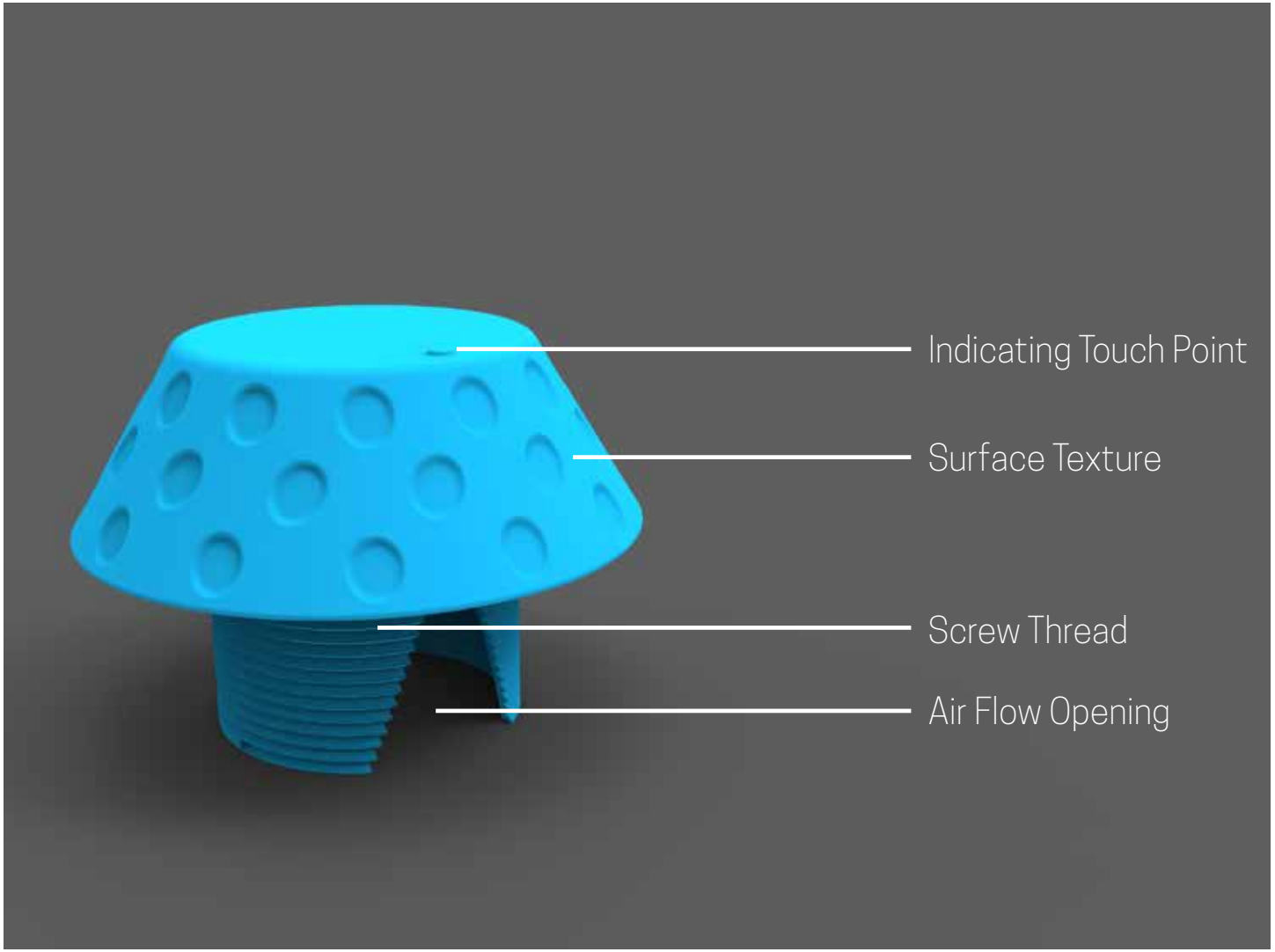
Resistance Graphic

Although the resistance caps can not be seen by the user when the product is in use the adjustment can still be applied by the user before the mask is worn. The three options on the far right are exploring some different graphic layouts that can help aid the interaction. Using the 8 markings alongside the pointer graphic the user can select 8 different levels of resistance. The bottom graphic uses the size of the graphic to show the maximum and minimum. The picture not aligned with the others however is proposing that the resistance caps do not even use a graphic, rather they use different size textured bumps. Taking inspiration from a brailled surface to allow the user to not only see the adjustment but to feel the levels of adjustment with their fingers when the product is worn.





Resistance Graphic



This resistant cap uses all pieces of research and development for the design and will be shown at the projects design freeze.

The cap uses an indicating touch point to allow the user to feel where they can adjust the resistant cap. The surface texture allows the user to physically feel the resistant cap and is implied to give a sense of grip within the adjustment.

The screw thread is used in combination with the air flow opening to allow the air flow to be resisted and allows the user to adjust the masks resistance level.

Oscillating Breathing

Oscillating breathing is something that needs to be avoided within sporting products. This is the process within breathing when a user is not getting a steady flow of oxygen and the user breathes carbon dioxide instead. Breathing this carbon dioxide can result in cramps and even numbness within exercise and can negative affects on sporting performance. (Ameo, 2017)

The Ameo Powerbreather (pictured right) is a product designed for swimmers so they can breathe while underwater. Oscillating breathing would have been an issue within this product however using valves the design allows oxygen to flow in and carbon dioxide to flow out. (Ameo, 2017).

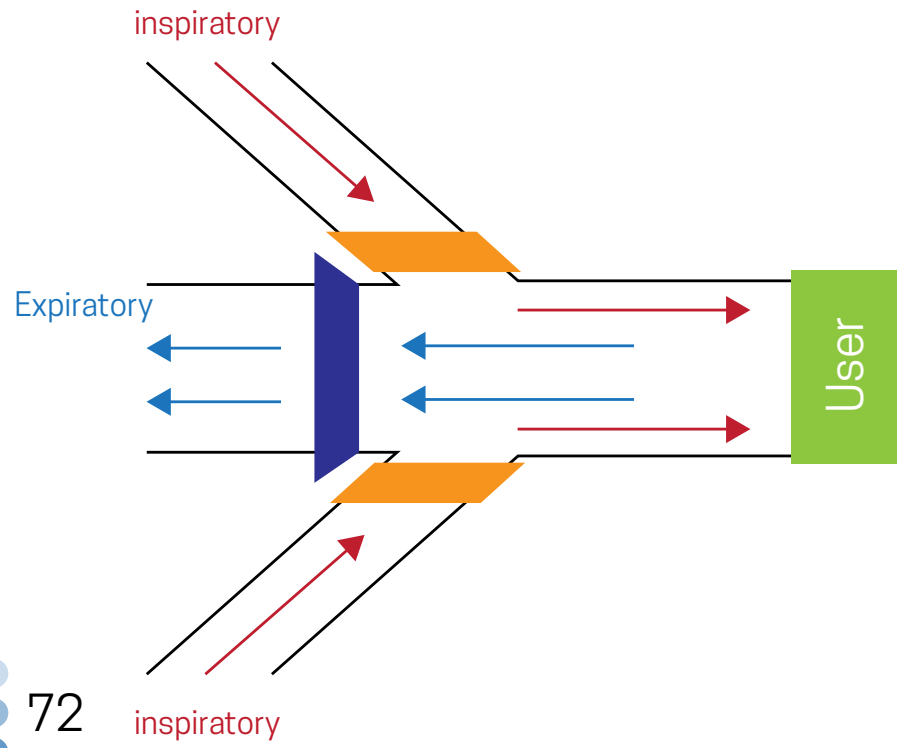
Within the concept this something that needs to be considered to make sure the user is breathing the oxygen air flow rather than carbon dioxide.

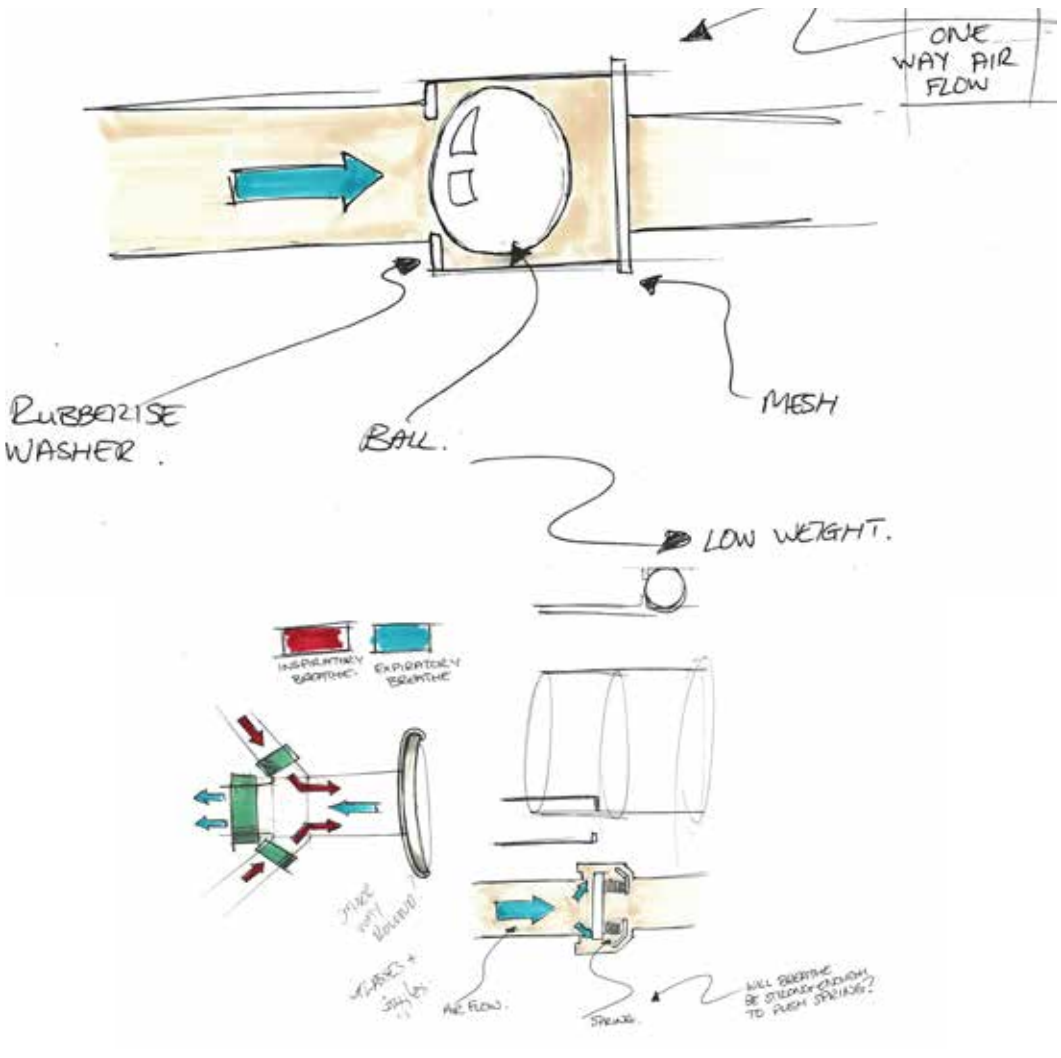
Fig. 027

One Way Air Valve - Mechanical

One way air valves are required to help the product avoid oscillating breathing, as well as this they will be needed to help the users air flow take the right path within the product. To achieve this desired air flow one way air-valves will be put in place to avoid their breathing becoming a hindrance to the product.

One way air valves can work using mechanical mechanisms. These mechanical valves have been explored to identify whether they would be the most suitable solution within the design. A diagram below has been created to show where the one way air valve systems will be put in place. The orange shape is where the inspiratory air valve will be and the blue for expiratory.





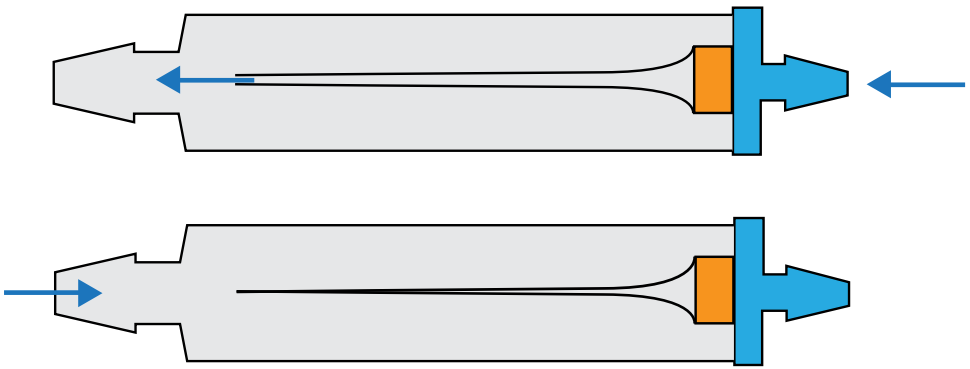
The first method in which one way air valves could work is with a mechanical function. One mechanical option is to use a plastic stopper backed with some springs, the springs allow air to push and flow through one way, however when air flow pushes from the alternate direction the moulding will prevent the air flow. The other option is to use a ball within a housing that again allows air to push it one way and not the other. Both options have been explained above.

One-Way Air Valve - Material

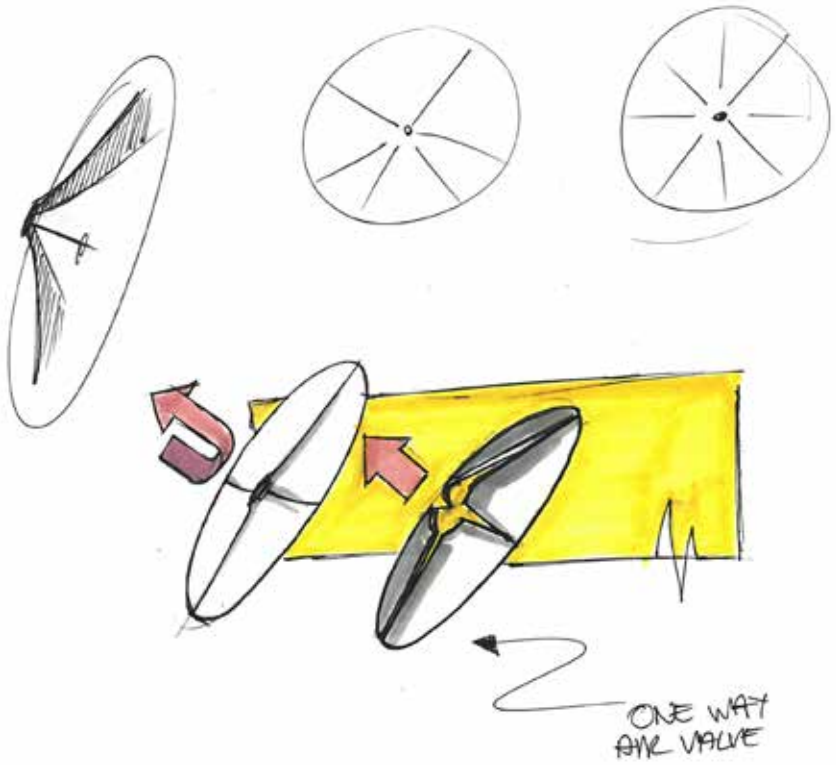
Other than mechanical one way air valves the same job can be achieved using a material with the correct properties and form. One example of this is called a flutter valve. A flutter valve is normally used within respiratory medicine to prevent air from traveling the wrong way.

The flutter valve uses a simple array of materials to achieve this function. As the air flow travels in the desired direction it passes through a nozzle and then through a silicone tube with a thin wall thickness. As the air travels through the tube it opens the tube and air can escape. However, when air travels in the opposite direction the flow of air can not open the silicone tube resulting in the air being blocked. A diagram below hopes to explain the process. (Sheeley, 2012)

Open Air Flow

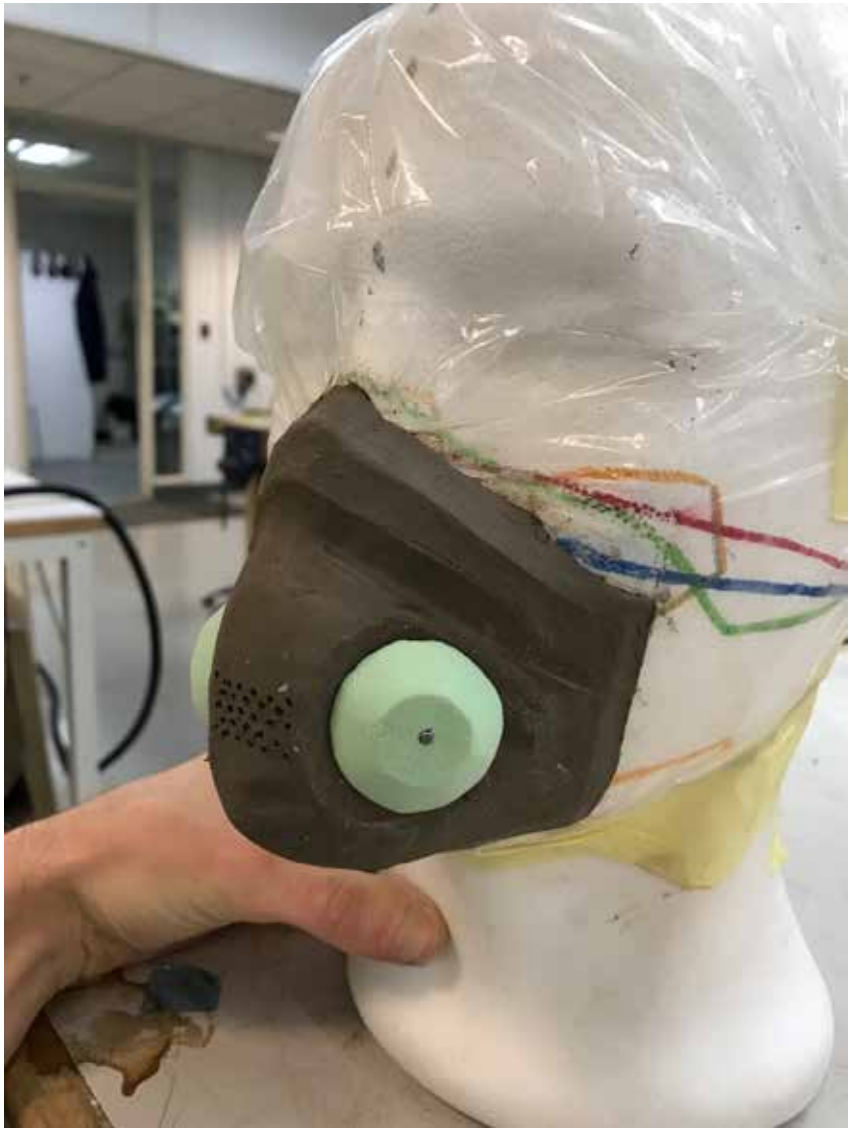


Closed Air Flow



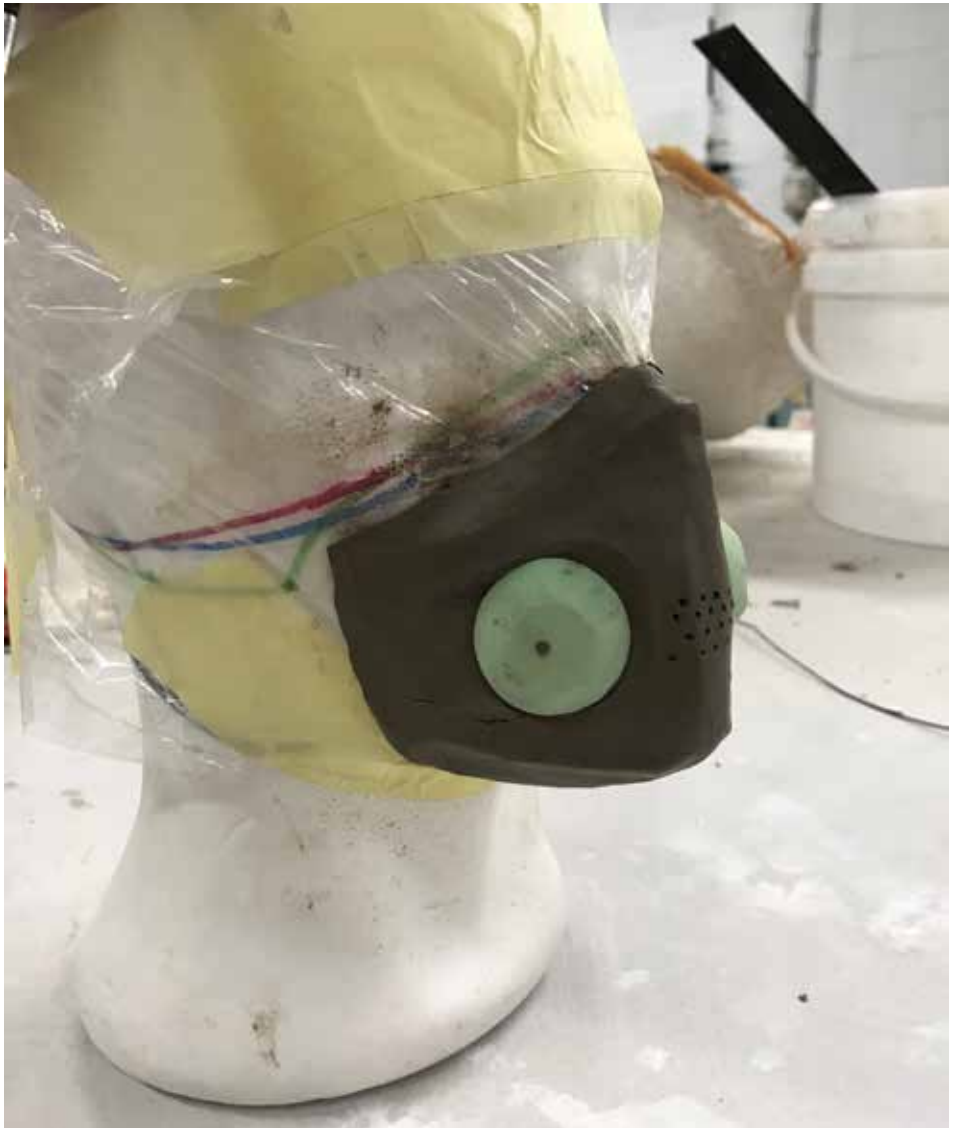
The decision was made to use the flutter valve system within the design. One of the reasons for this is due to the flutter valve being currently used within respiratory products proving that the option can work with the air flow speed, where as the mechanical options would in theory work, their is worry that a persons breath might not be strong enough for the valves to work.

Form Model



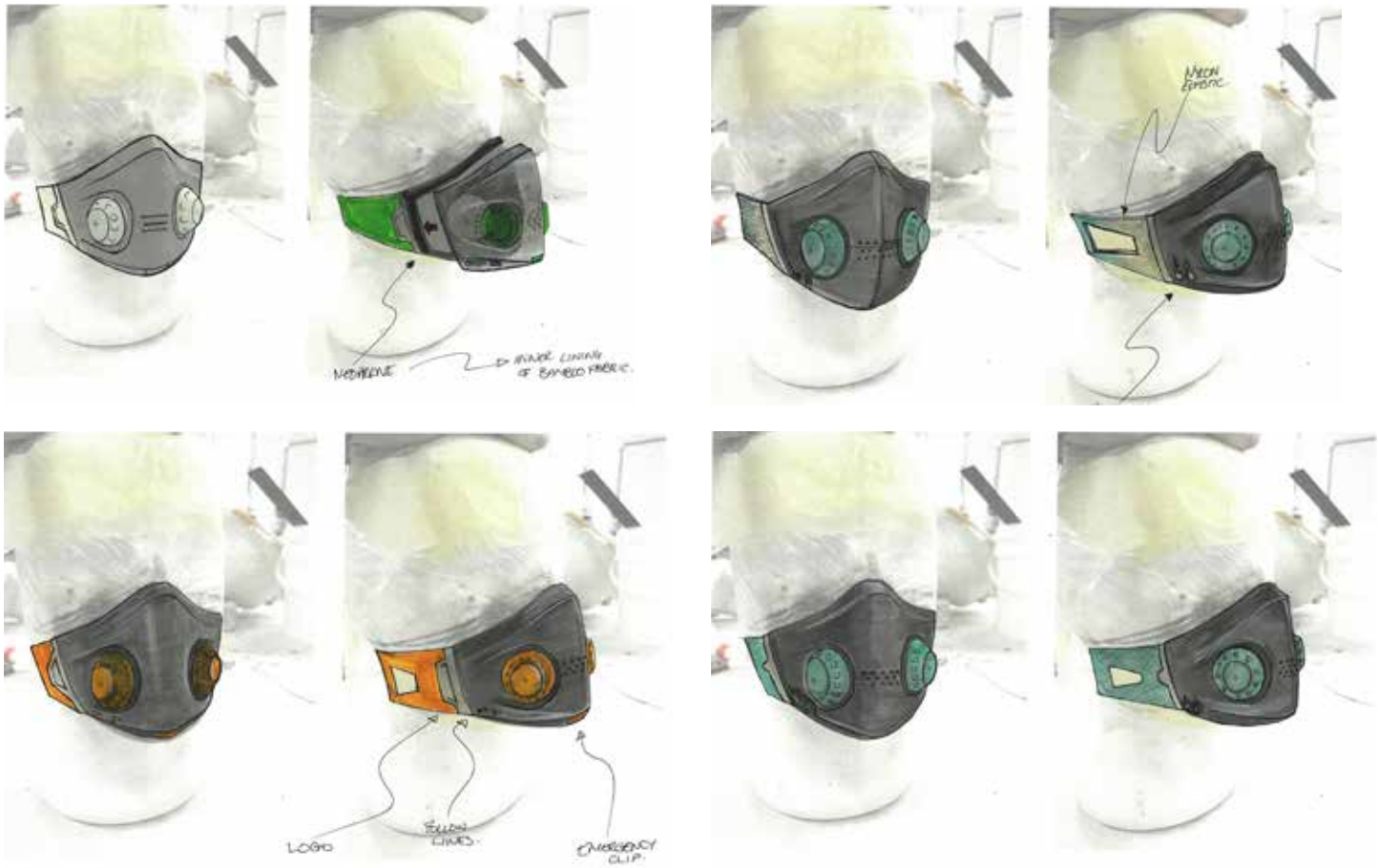
A form model was created out of clay to identify the form of the mask. The first iteration was taken influence the encapsulation motion page. Within the design the upper ridge has been purposely placed to extenuate the air flow. The resistance caps also sit within a slight hole again to reduce the size of the design. The expiratory breathe will flow out of the holes in the front of the mask allowing the carbon dioxide to be expelled into the open air.

Form Model 2



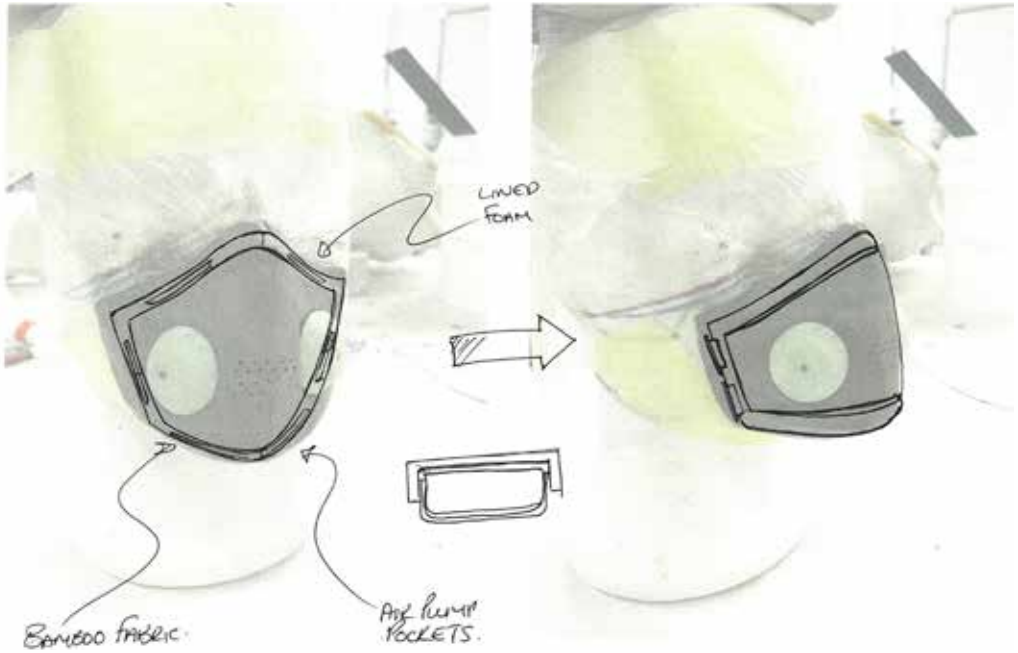
Form model 2 was made to explore the aesthetics of the masks outer shell. The model featured a more distinct top ridge to try and emphasis the masks features around the resistance caps. The model under cuts slightly along a proposed split line to allow the product to occupy less space on the users face.

Form Model - Developed Sketch Responses



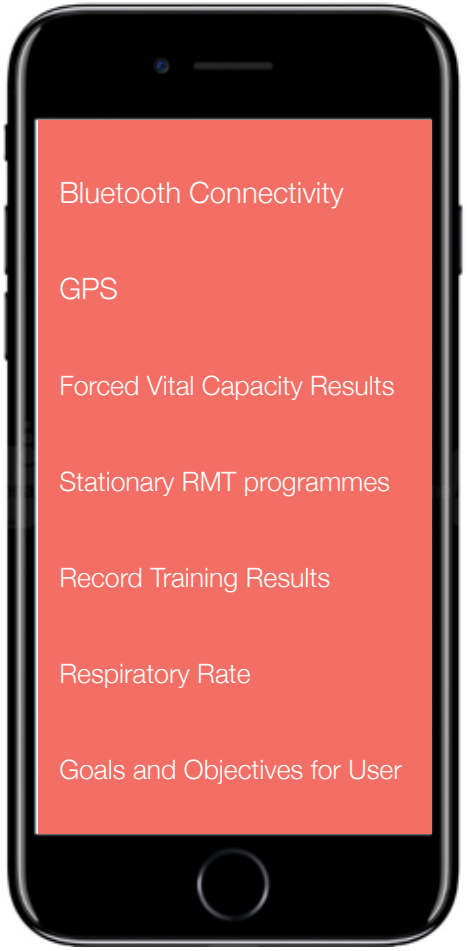
After the clay modeling process the masks form was refined with sketching. The sketches were looking at how the mask will transition from one material to another.


NEED LED
FEEDBACK.


LINED
FOAM
BAMBOO FABRIC.
AIR PUMP
POCKETS.

App Functions

The mask will have the ability to pair to the users phone, using a companion app. The app will utilise a number of features using the process power of the modern smart phone.



Bluetooth Connectivity

The product and phone will both need to pair with one another using bluetooth technology. This means the product will have to incorporate a bluetooth card. This technology will allow the product to work in harmony with the users phone to enable the user to optimise their performance.

GPS

Using the smart phones GPS system within the app will allow the user to track where they have been running/cycling. It will also allow them to view the distance they traveled and in what time. This features will be a great asset to help users understand their own performance to identify routes for improvement.

Forced Vital Capacity Results

Forced Vital Capacity (FVC) results will allow the user to view their own lung performance. This is a vital feature for the user to view and plot their performance results so they can view their improvements over a period of time.

Stationary RMT Programme

Stationary RMT programmes will be built into the app to allow the user to practice RMT with the product when the user is not taking part in active exercise. There is a great deal of RMT exercises that can be done when the user is stationary and this is a efficient method of improving lung strength and endurance.

Recording Training Results

Giving the user the ability to record their training results will allow progress and improvement to be measured. Using this data individuals can focus their exercises to understand what they need to do to optimise their own performance.

Respiratory Rate

An individuals respiratory rate is a key factor when exercising, allowing the user to view their respiratory rate will give the user a chance to adapt their breathing to improve their own performance.

Goals and Objectives

The app will give the opportunity for the users to plot their goals and objectives for features like their respiratory rate, forced vital capacity results and stationary RMT for the user to try and improve their individual performance.

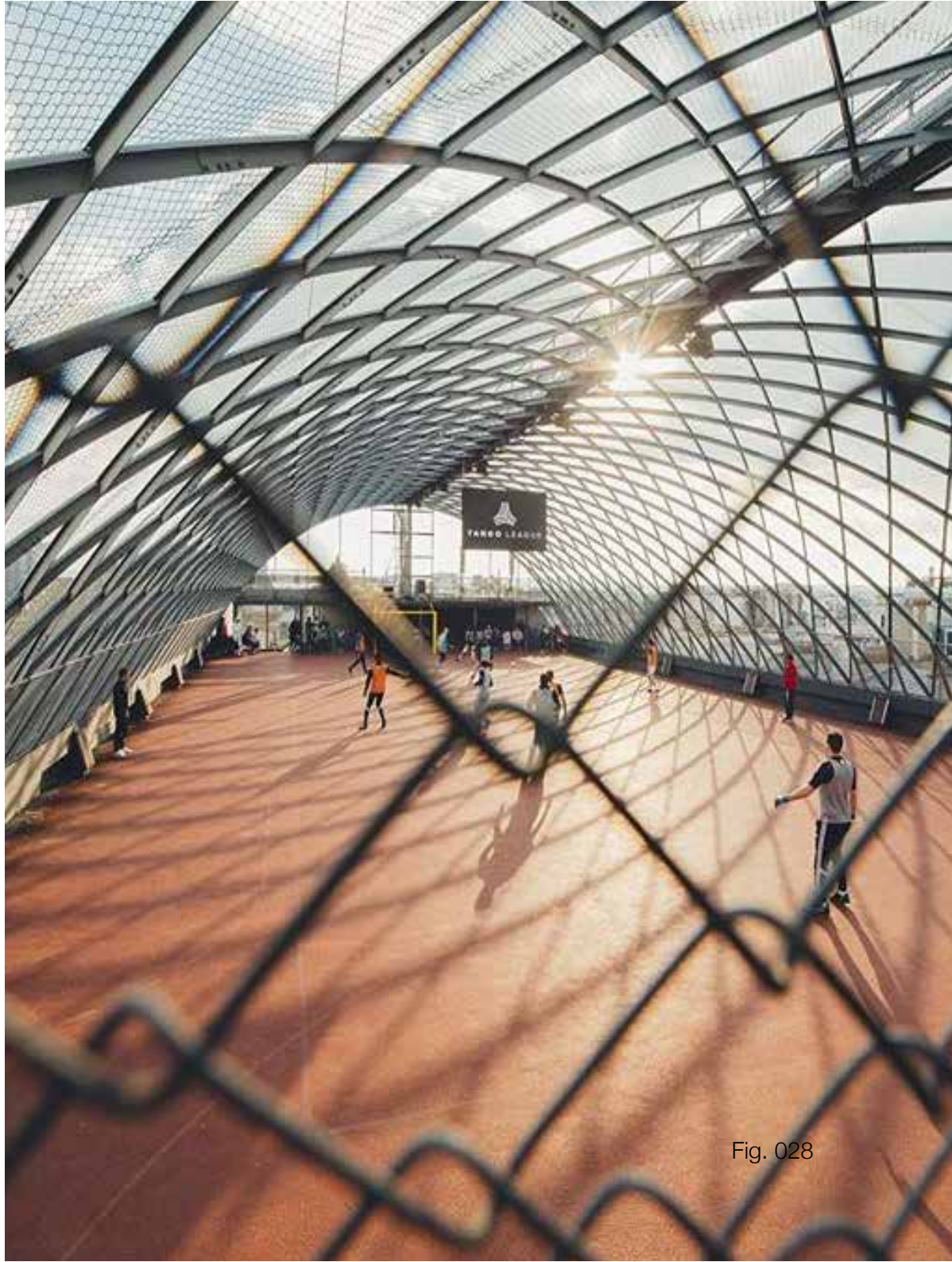


Fig. 028

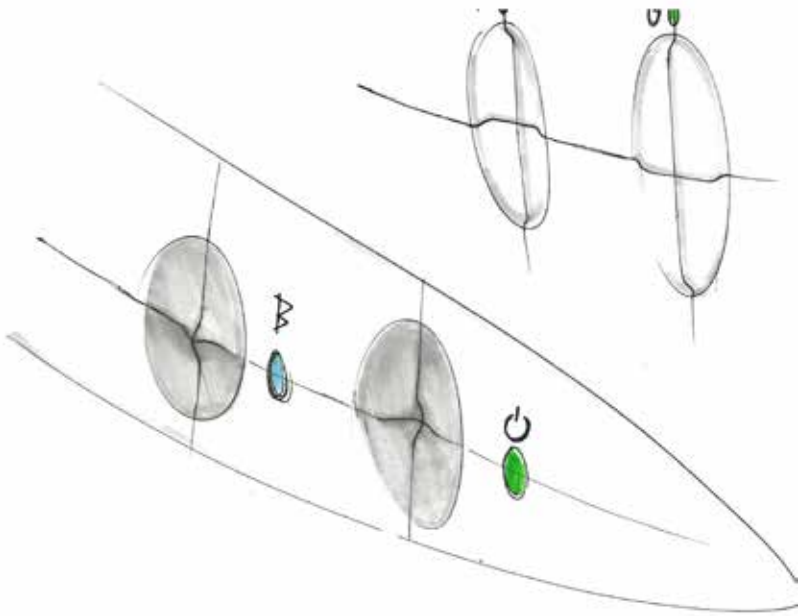
Bluetooth Function

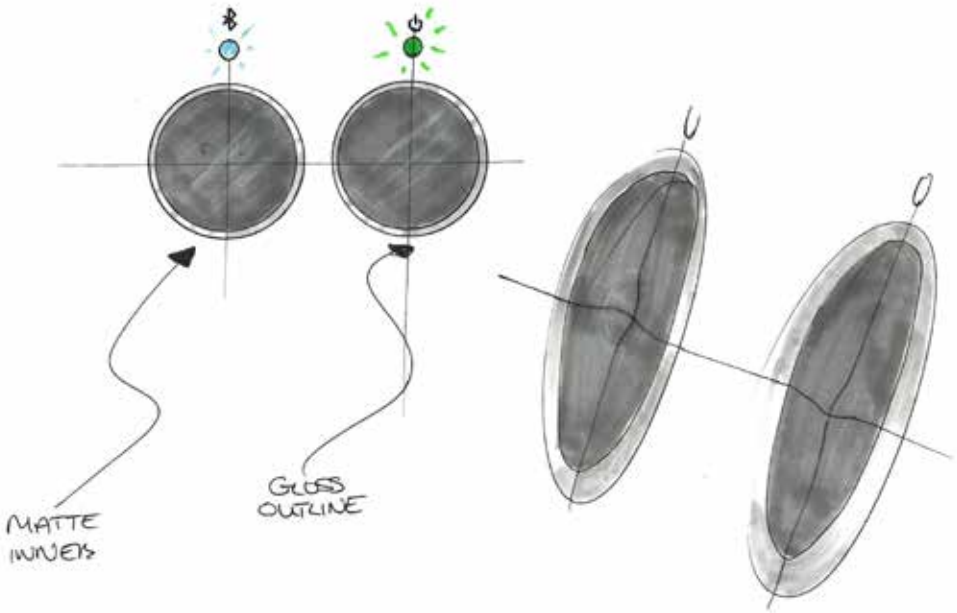
How the user pairs their product to the app is an important process and requires the human interaction with the product to be explored. The user will have to pair the product to the companion app whenever it is being used. A number of different options were explored into how the user could interact with the product to achieve this function.

The bluetooth would work using a bluetooth low energy module that would give off a short traveling signal that would be received from the smart phone. This pairing option will allow all of the app functions spoken about on the previous page to work within harmony.

Bluetooth 5.0

Bluetooth 5.0 is the latest release from Bluetooth. Still using a low energy that pairs to “slave” adapters the bluetooth module will be able to transport data at a much quicker speed. (Bluetooth, 2017)





Electronic Internals

Within the mask their is a number of small electronic components that will work in conjunction to bring the product to life. The electronic components needed for the mask to perform are as followed.

- Battery
- PCB
- Air Flow Pressure Sensor
- Speaker

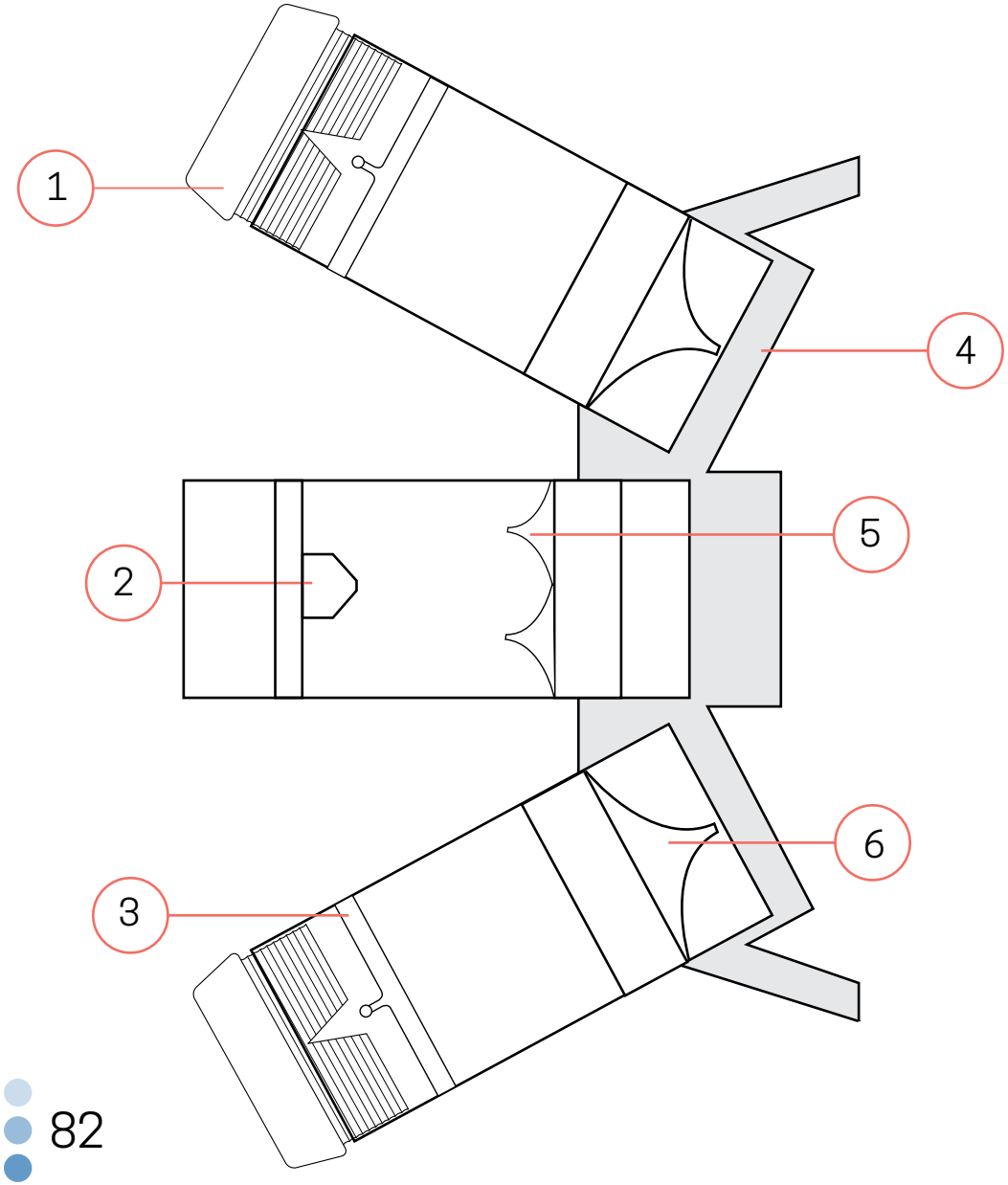
The most technical part out of these electronic internals is the air flow pressure sensor. The air flow pressure sensor works by heating a small wire within the module. Once air passes through this module this has an effect on the temperature of the wire. How quickly this wire changes temperature and how drastically allows the sensor to work out the air flow pressure of the users breath. (First Sensor, 2017)

Fig. 029

Fig. 030

Fig. 031

Breathing Internals



1.
The resistant caps will be placed on the end of the inspiratory air passages. Using a screw thread they will give the user the ability to adjust their air flow resistance.

2.
When a user exhales their expiration breathe will need to be recorded using an air flow pressure sensor, this will relay to the PCB and the bluetooth card.

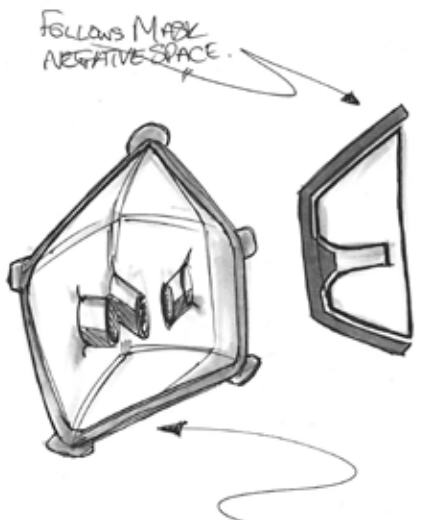
3.
The air filter will be place in both inspiratory passages they will feature a small toggle that will allow the user to replace them after they have collected their maximum pollution residue.

4.
An internal lining of medical grade silicone in place.

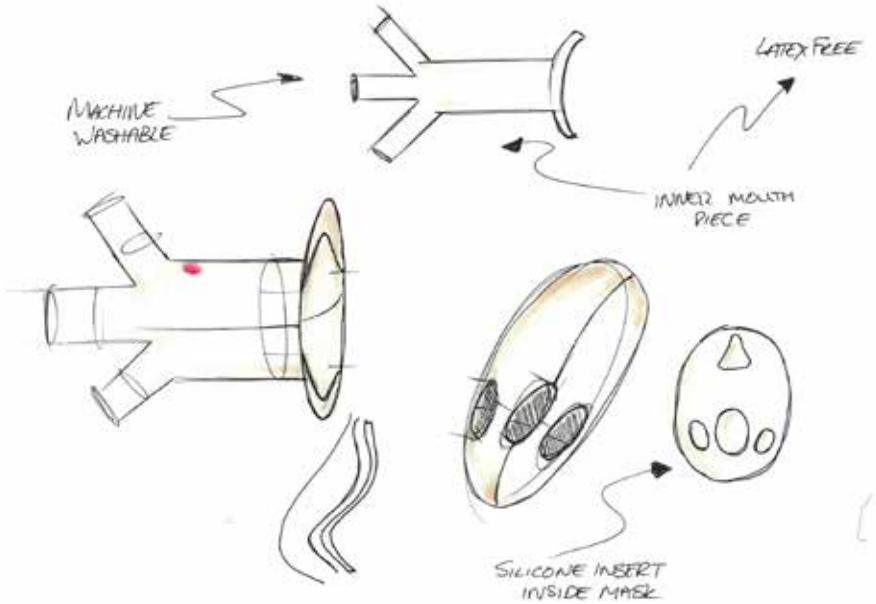
5.
The expiratory passage will feature a flutter valve that will allow the user to exhale through the correct passage, enabling their air flow to be recorded by the air flow pressure sensor.

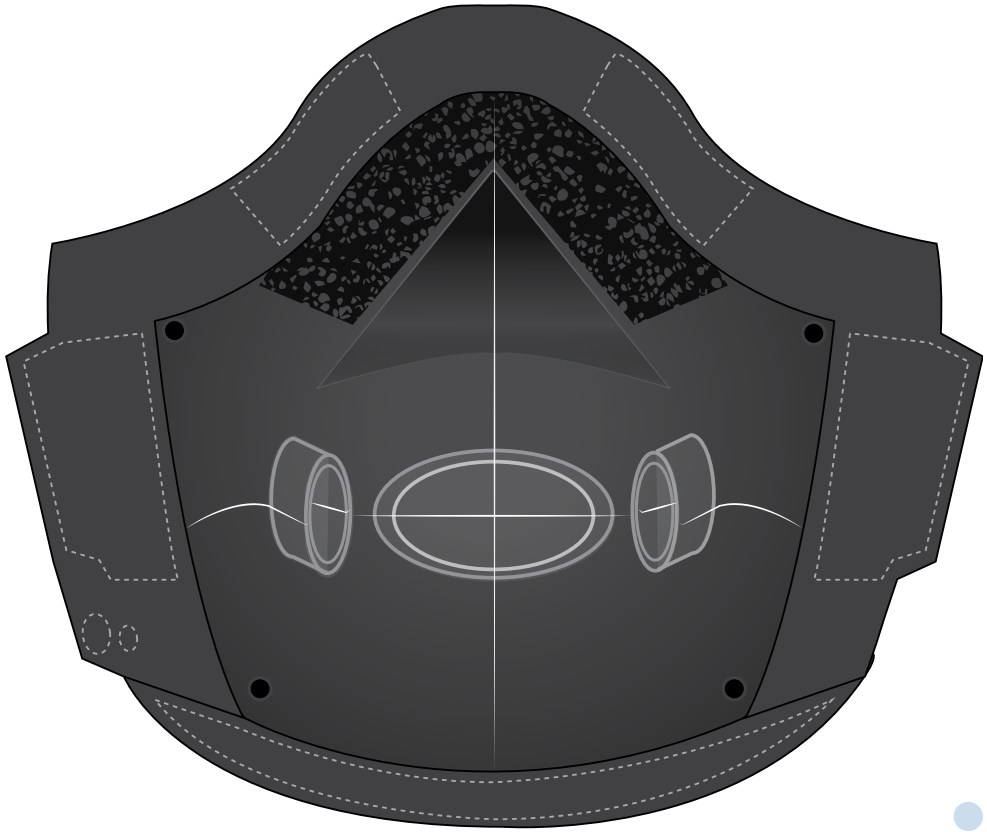
6.
The inhaling passage will feature a flutter valve to allow the user to inhale through the resistance caps.

Hygiene



The mask would need to be cleaned after every use to avoid bacteria build up on the inside of the mask. To resolve this issue the mask features a silicone insert that will be follow the internal surface of the mask. The user can then peel the internal medical grade silicone from the inside of the mask and wash either in a dishwasher or by hand.





Material Choices

Zytel® HTN Polyamide (Dupont) - Main Body

Nylon Elastic- Straps

Neoprene - Face Covering

Bamboo Fabric- Mask Internal Lining

Silicone - Inner Mask Internal Lining

ABS - Resistance Caps

Polyurethane - Air Pump

This plastic has been selected as the material used for the main body of the mask. The high performance Nylon has been selected due to it giving the mask structural strength as well as being very light weight. The plastic can be molded very easily allowing the flowing form to be molded and hold its shape. (Dupont, 2017)

The Nylon elastic straps is a similar material to those used within ski goggles. The natural stretch in the material will allow a comfortable yet secure fit.

The neoprene facial material has been selected due to the elasticity within the material. The neoprene will also be used to allow structure of the mask to be attached.

The bamboo fabric has been spoken about earlier within the logbook. The bamboo fabric is a wicking material, to help reduce sweat build up around the mask.

The silicone material was used to allow the internal lining to be washed. It can be washed using methods like hand washing or placed within the dishwasher to improve hygiene levels within the mask

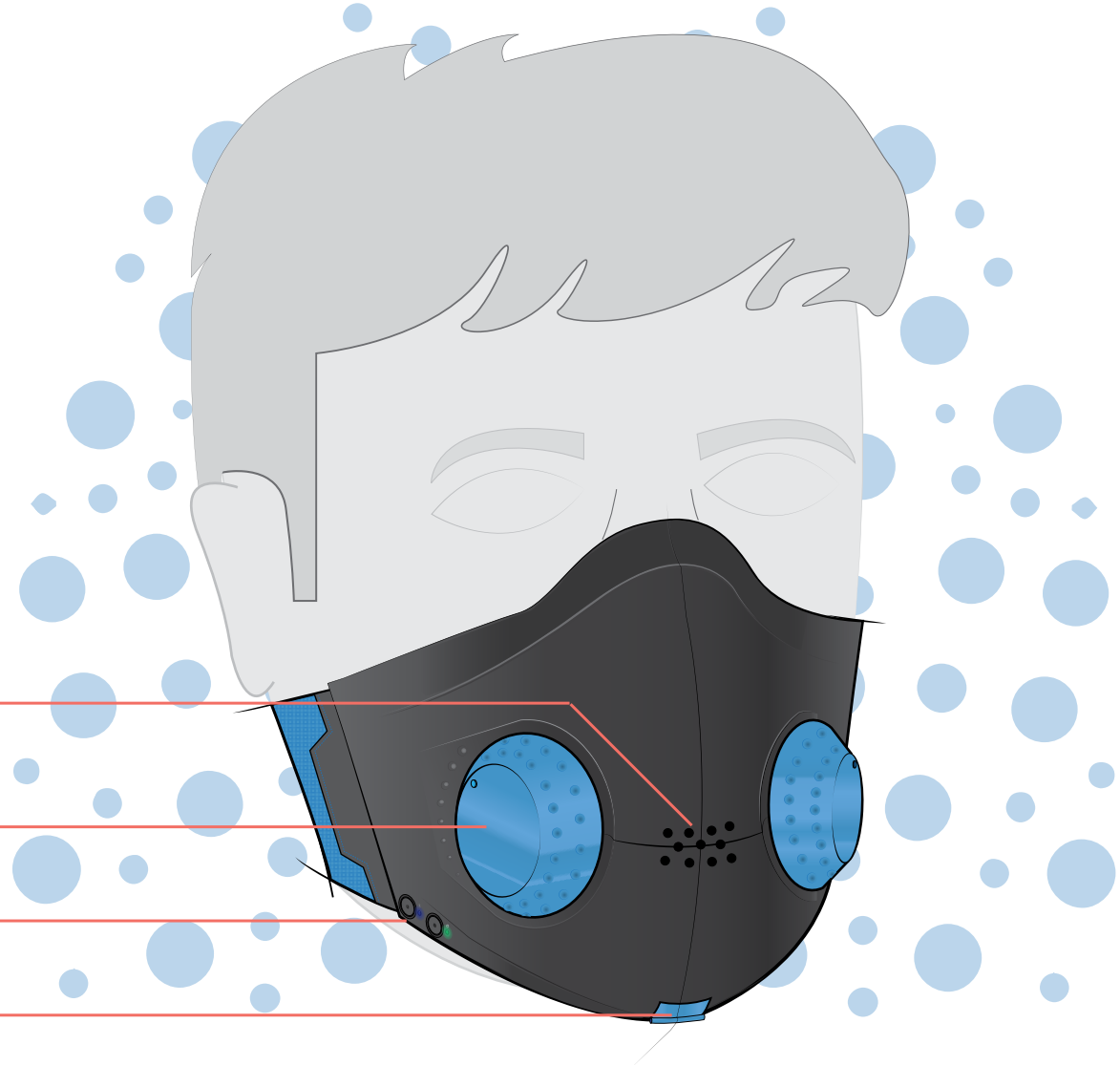
The ABS resistant caps were selected in this material to allow the caps to take a screw thread that will work with a small tolerance level. This will also come from the tooling of the part. “Manufacturers like K&B can also use machining capabilities to meet extremely tight tolerances when necessary.” (J, Berberich. 2016)

The Polyurethane has been selected to allow the air pump to allow the user to use a flexible material to pump the masks inner adjustment fit.

Design Freeze

At this point in the project a design freeze took place in which the project got the opportunity to be presented to gain some feedback on the project and design.

This was the concept that was presented.



Feedback + Reflection

The feedback from the design freeze was mostly positive. The design was coming together however, there was still a lot of work to do be done. The points that were discussed mostly was about the emergency feature that was stated still needed work.

The other aspect spoken about during the feedback was the HEPA filter, the filter needed to be looked into to make sure it would not have any impact on the users breathing.

Personal Reflection

At this point in the project the design freeze gave me the opportunity to reflect on my own project to look at whether it was going in the right direction. Personally I felt I needed to refine the design and to look into the overall aesthetic of the product. The target market for the design was for both men and women and I felt personally the design was becoming very aggressive and masculine. The design was going to have a re-think to identify how this could be changed and improved.

New Aesthetic Inspiration

Fig. 032

Fig. 033

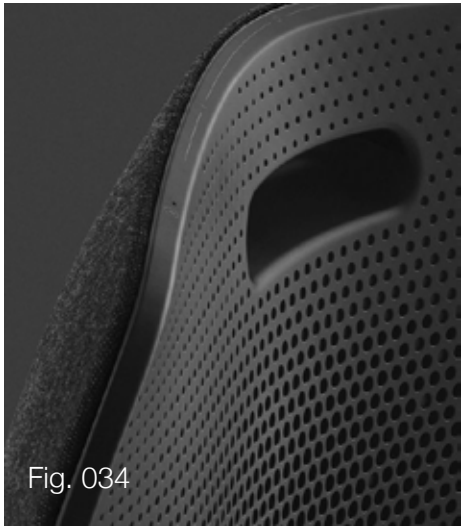


Fig. 034


Fig. 035


Fig. 036

Direction Change

After some reflection from the design freeze the project was over viewed within a tutorial. The question started to immerge whether a mask was the correct solution for the project. The discussion was debating whether a mouth piece could be a more suitable and well rounded solution for the user.

The Pro's and Con's for each where weighed up to identify what path was correct for the project.

Key Research Insight

Powerbreather is the most common piece of respiratory muscle training products on the market today. After the discussion it was made apparent that I needed to identify scenarios in which the product will be used. The Powerbreather is used for resistance training and they recommend a user takes part in resistance training in a 30 breath workout twice a day. This means the product that will be designed will take this same set up. The user will use it twice a day for 30 breaths. This outlines that a mask would be a less appropriate option. (Powerbreather, 2017)

Mask

- Holds to face without needing to hold

- Can be done during most exercise regimes

- Forms a seal for breathing, easier for the product to work properly.

Mouthpiece

- Lightweight Design

- No facial sweat

- Less stigmatisation around a mouthpiece

- One size fits all

- Takes inspiration from the Powerbreather using a 30 breath work out, this has shown bigger improvements that any other breathing exercise trainer.

- No comfort issues

New Identified Problems

After a discussion with Nick Dulake from Design Futures and a tutorial the decision was made after weighing up the pros and cons for a mask and a mouthpiece the decision was made to change and look into designing a mouthpiece. Especially with the research found from the Powerbreather creator and respiratory expert Alison McConnell surrounding the 30 breath respiratory work out.

However, changing the format of the design has led to some new identified problems that will need to be resolved for the final concept.

Hygiene of mouthpiece being taking in and out of the users mouth

How is this product transported

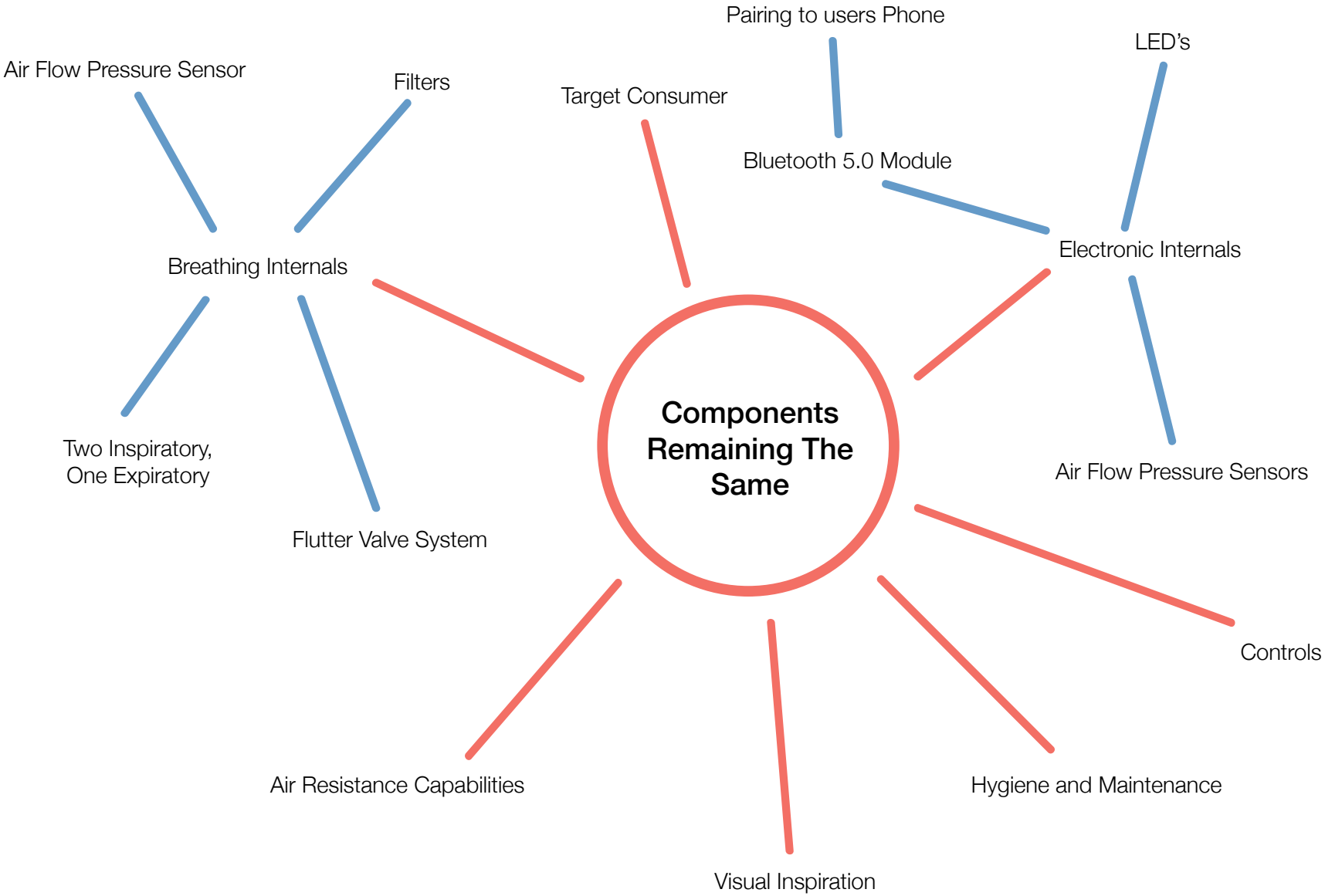
Product Story and scenarios

The format of the design needs to be looked at, control placement etc.

Product Styling

How will this product fit into users exercise regime

Components Remaining The Same



Foundation Inspiratory Resistive Training

Foundation inspiratory muscle training is seen as **phase one** of the respiratory muscle training regime, it involves using . Most of the best resistance trainers on the market today are using this training regime. **The regime involves using the training aid in a stationary standing posture for 30 breath work outs, twice a day** (Physiobreathe, 2017).

However, when this method is not used for a 30 breath workout the results become less reliable and many people have found a lack of improvement from using inspiratory resistive training over a period of time rather than a 30 breath workout like the finalised concept is proposing. The reason it lacks reliability in altitude masks is that when a person is using this resistance training when exercising the speed of their inhalation varies, meaning the resistance is constantly changing, making it hard for the lungs to improve. (McConnell, 2011)

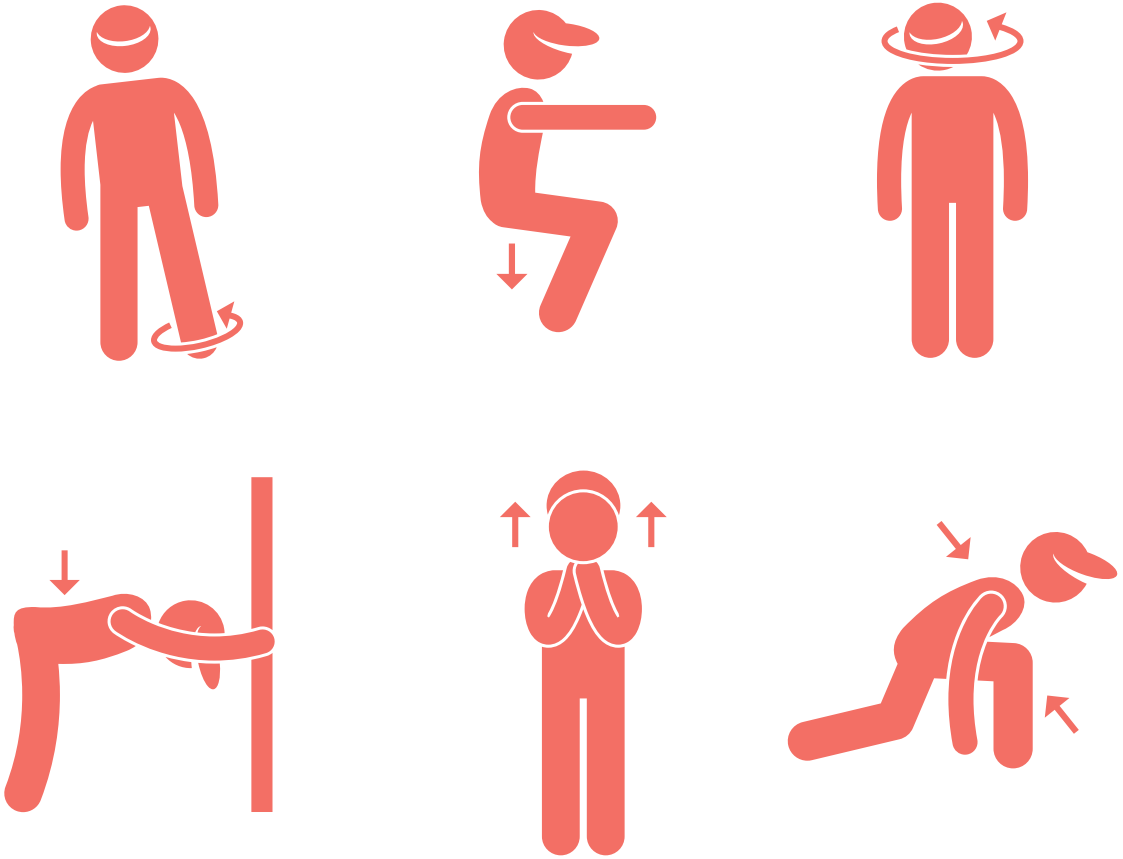
To make sure the final concept is truly improving a users lung endurance it will use inspiratory resistive training paired with air flow sensors, unlike any trainer on the market these air flow sensors will communicate with the users companion app, telling the user to maintain the same respiration speed when using the product. This allows resistance training to have a true improvement for the user, which would not happen when then is varied speed within the air flow.

Fig. 037

Functional Inspiratory Muscle Training

After a period of time usually around 8-12 weeks the foundation inspiratory resistive training will need to be changed to challenge the inspiratory muscles in their roles as both respiratory muscles and as the muscles responsible for postural control, core stabilisation and trunk rotation. This is called Functional Inspiratory Muscle Training and is phase two in the new concepts work out regime.

This can be done by the user by taking part in specific exercises. This change to the workout again helps form an improvement in the respiratory strength of the user. Seen by some this technique is referred to as a “dumb bell for the lungs”. (Physiobreathe, 2017)



Some examples of functional inspiratory muscle training exercises. Dumb bells and weights can be used to increase intensity of workout

Market Competitors

Name: POWERbreathe Plus

About: The second generation from the Powerbreathe brand, the Powerbreathe plus. Designed for sporting activities the Powerbreathe uses a variable load calibrated spring to enforce pressure for the user.

Mechanical or Electronic: Mechanical

Price: £49.99

Review:

- Not suited aesthetic to the target sporting demographic
- Good use of variable adjustments, (clear to the user)
- No user feedback on training improvements.

Fig. 038

Name: POWERbreathe K4

About: Te third generation by POWERbreathe, the K4 uses the same resistance method as the POWERbreathe Plus. However, the user of the K4 can benefit from auto-optimising, training guidance and the ability to view training results.

Mechanical or Electronic: Electronic

Price: £425

Review:

- Not suited aesthetic to the target sporting demographic
- Great training improvements due to results being stored
- Breathing linked to software to optimise training.

Fig. 039

Name: Respironics Trainer

About: Using the a loaded pressure the respironics IMT is seen as more of a medical device to combat conditions such as COPD.

Mechanical or Electronic: Mechanical

Price: £17.99

Review:

- Not suited aesthetic to the target sporting demographic
- No user feedback on training improvements.
- Undesirable product, no good key interaction points for user.

Fig. 040

Name: Expand-A-Lung

About: This is the most durable breathing device on the market, more suited to sporting activities than a lot of competitors.

Mechanical or Electronic: Mechanical

Price: £70

Review:

- Not suited aesthetic to the target sporting demographic
- Easy adjustment system
- Undesirable product, no good key interaction points for user.

Fig. 041

Name: o2 Trainer

About: The o2 trainer uses a simple tile adjustment that users change to alter resistance. The device uses a mechanical structure to limit air flow to the user

Mechanical or Electronic: Mechanical

Price: £49.95

Review:

- Not suited aesthetic to the target sporting demographic
- Poor adjustment system.
- Undesirable product, no good key interaction points for user.

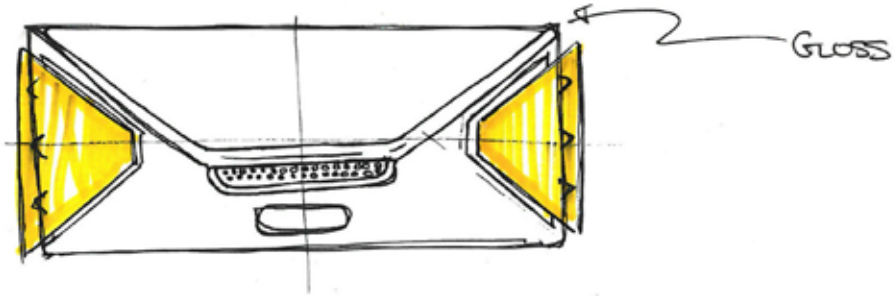
Fig. 042

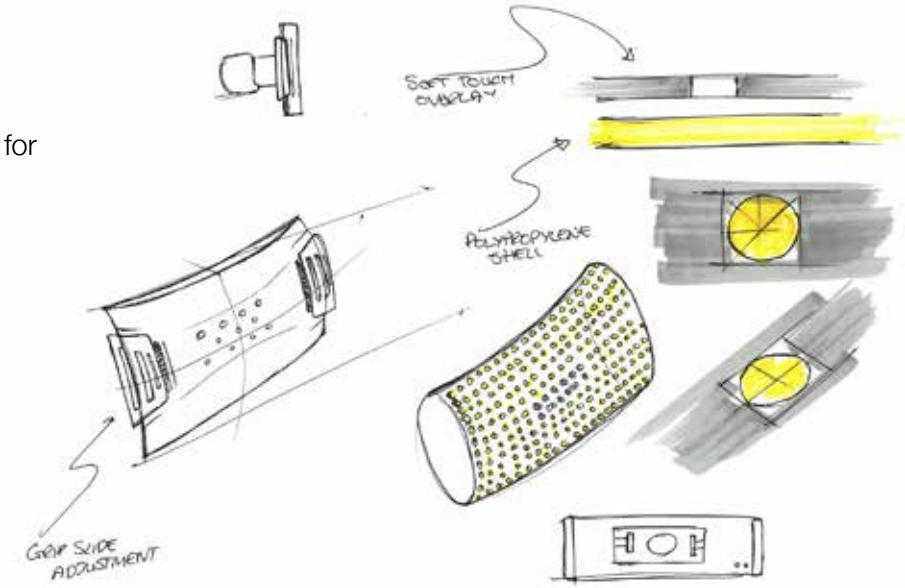
Market Research Reflection

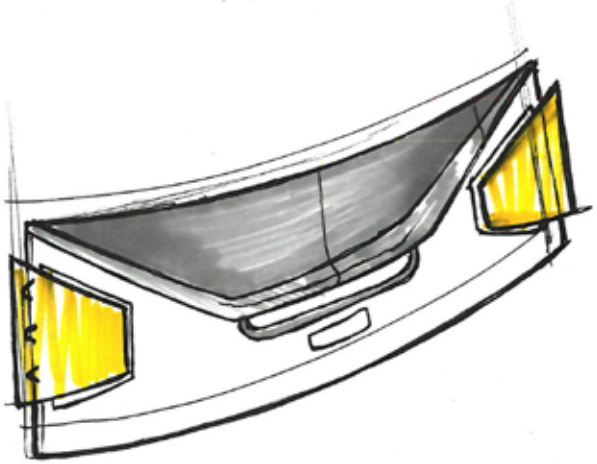
Moving forward the respiratory muscle training device will take inspiration from the best points from these devices. For example, the software feedback available on the Powerbreathe allows the user to easily view and plot their training regimes to achieve better results. None of the devices have a suitable aesthetic for the sports industry, this is something that will help the product to become a market leader. None of the products have a strong brand presence, something vital for sports products.

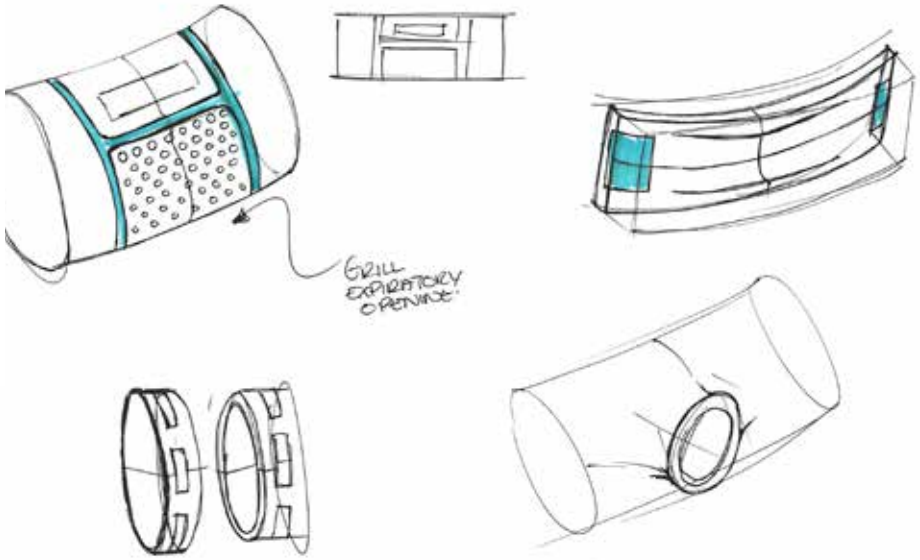
Initial Concepts

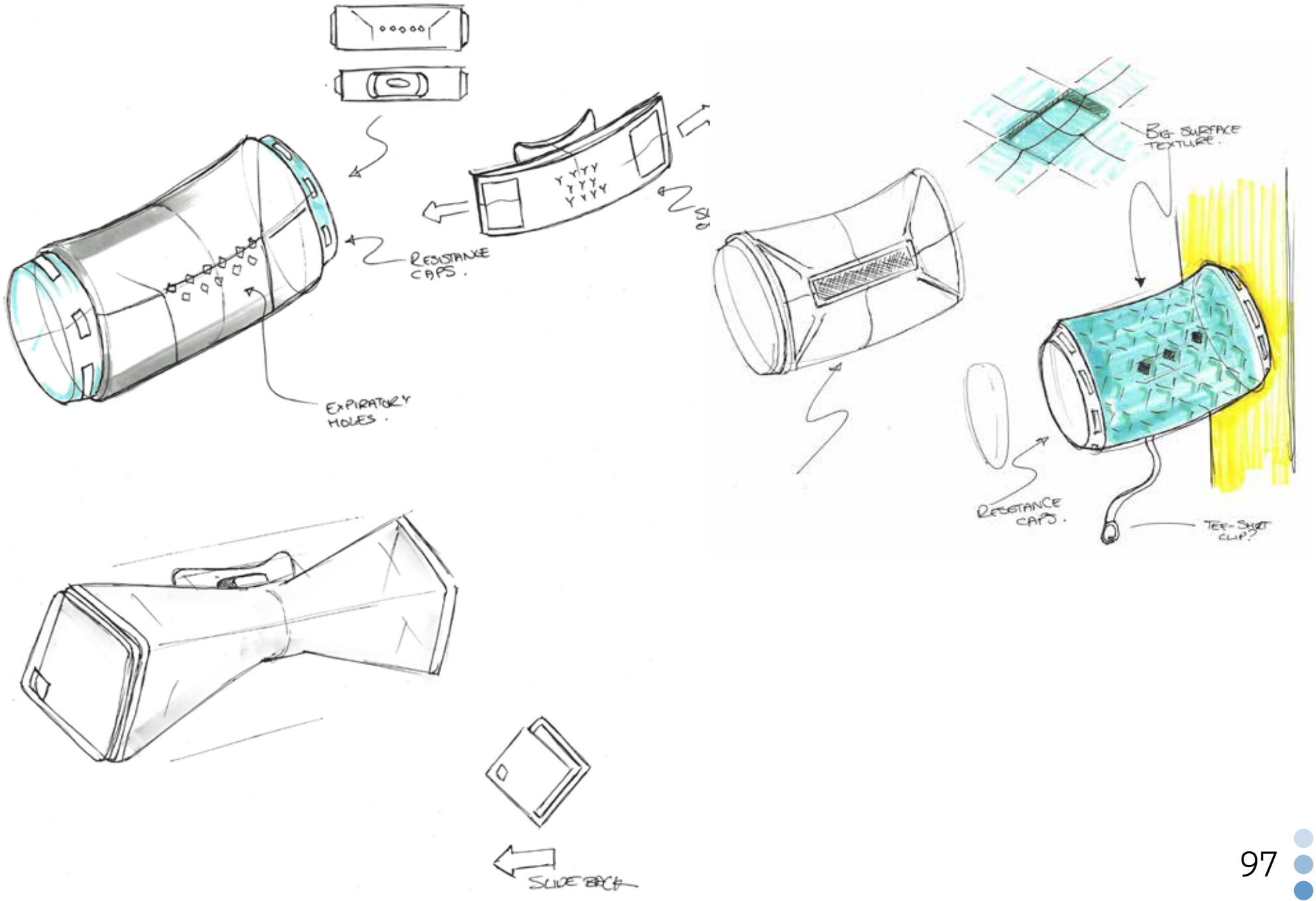
A series of concepts were developed to look into how the mouthpiece could be used for the consumer. Initial concepts were exploring form and the format of the design.










RESISTANCE CAPS.
EXPIRATORY HOLES.
BIG SURFACE TEXTURE.
RESISTANCE CAPS.
TEE-SHIRT CLIP?
SLIDE BACK

Form Modelling





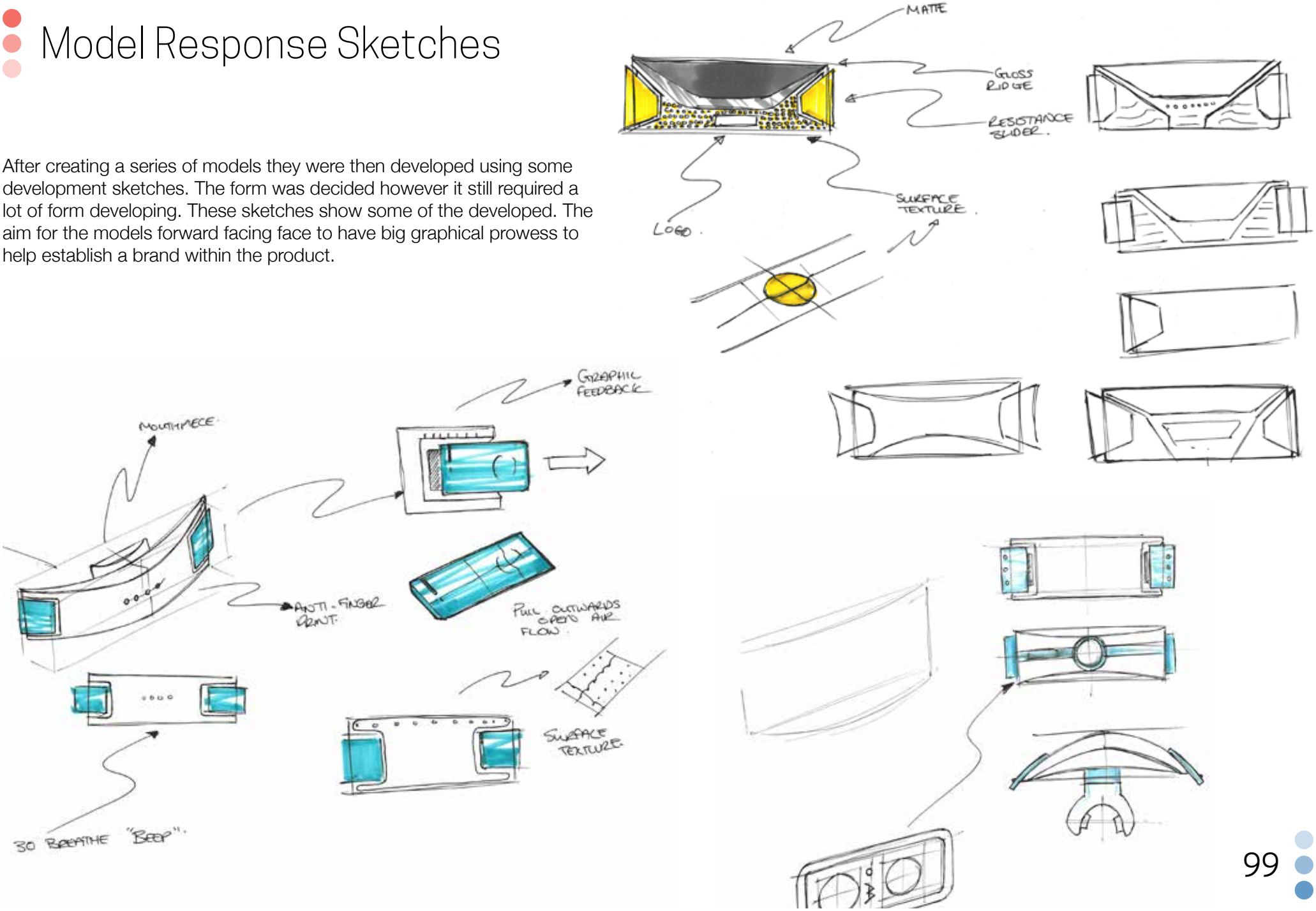




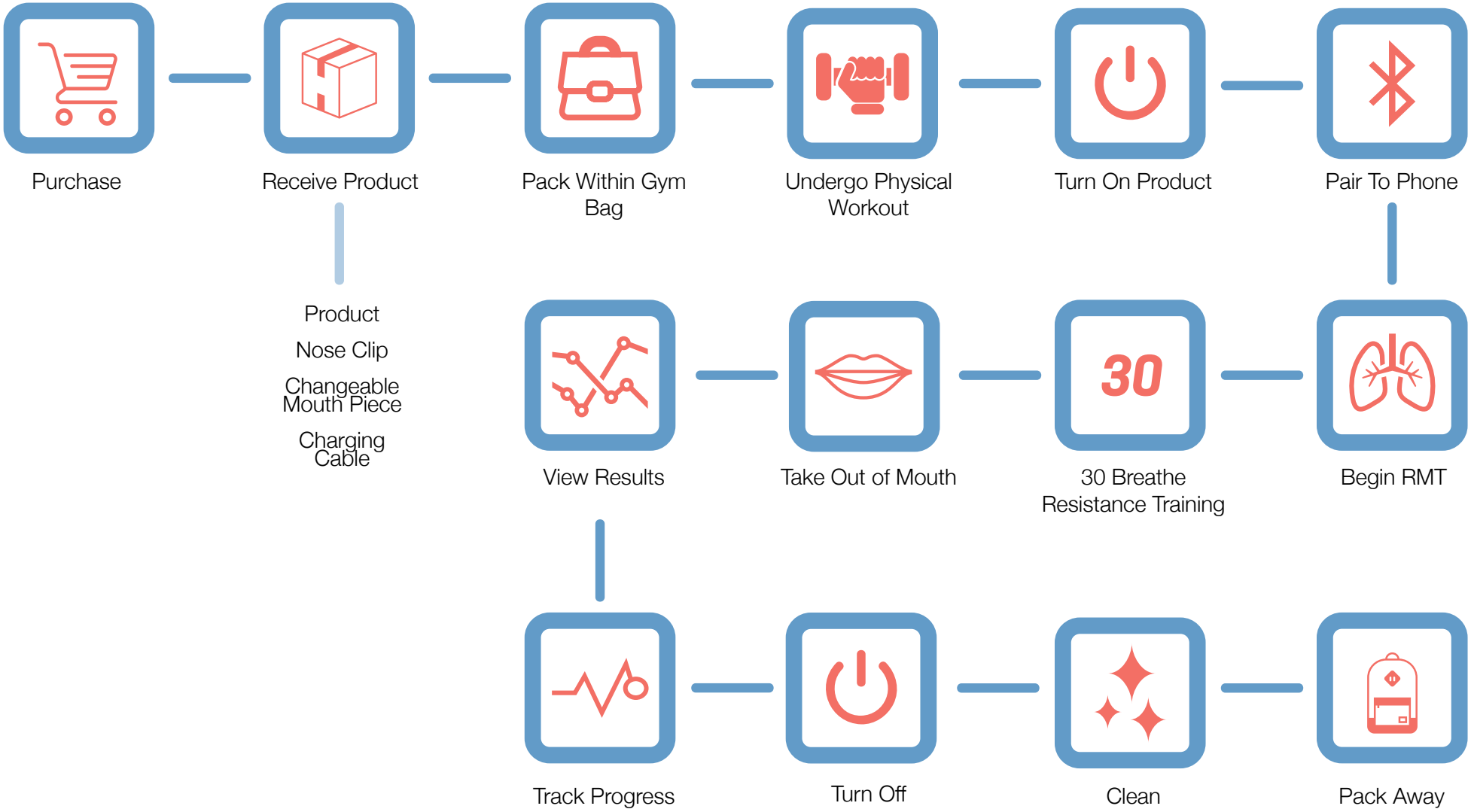

Models were developed to explore the form of the product. The form of the product wanted to portray performance. As well as this the aim of the form was to follow the users facial features and the curvature of the face, all these reasons led to the first model on the left being taken on to be developed.

Model Response Sketches

After creating a series of models they were then developed using some development sketches. The form was decided however it still required a lot of form developing. These sketches show some of the developed. The aim for the models forward facing face to have big graphical prowess to help establish a brand within the product.



Product Story



Optimising Training

To optimise the users training results the user will have to follow a series of guidelines to gain the best results.

- 30 repetition breathing maximum
- Stretch and warm-up before training
- Breath in and out as far as possible
- Train twice a day per day
- Increase training load over time
- Keep an progress report to plot improvements.

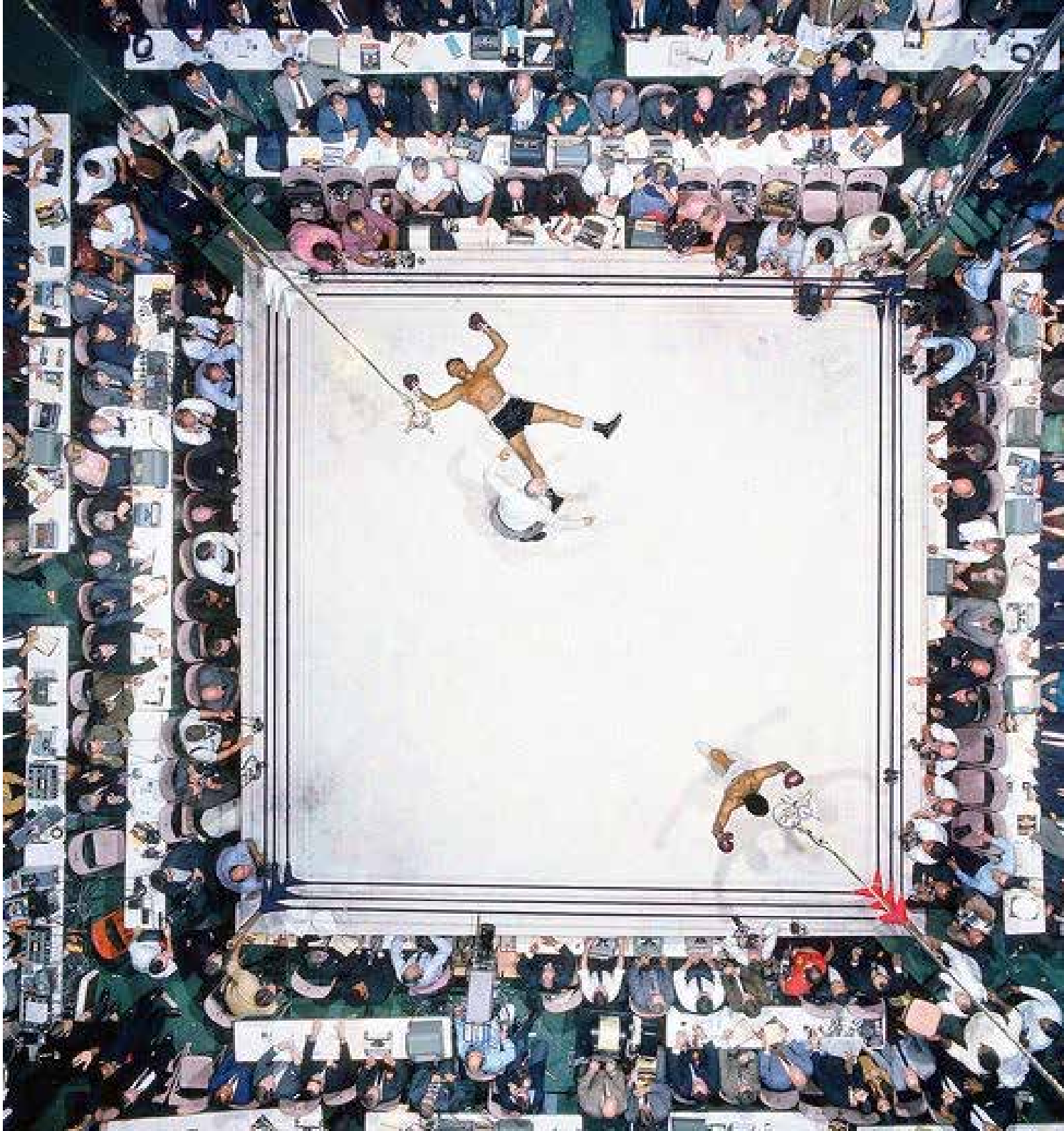
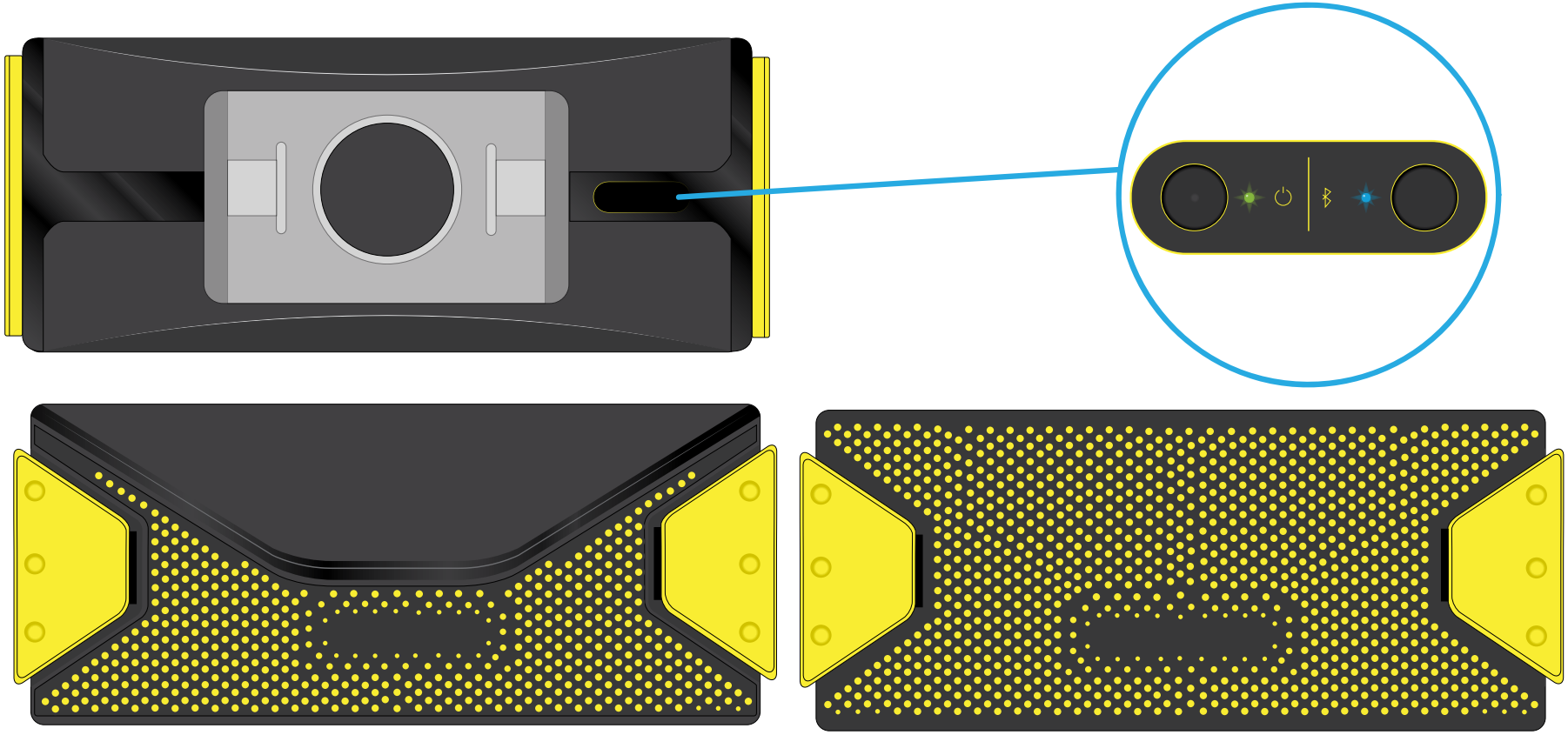


Fig. 043

Concept One



This first concept for the mouth piece features a polypropylene body that uses a plastic overlay. This overlay will fade as it approaches the middle to feature where the product logo would sit. Both concepts feature this overlay although the one on the right enhances the feature more. The problem with these current concepts however is that they do not portray the correct visual language for the product. The products above look too aggressive. The aim is to tone this aesthetic down and to portray air flow and motion within the concept.

Mouth Pieces

The mouth piece is a vital part of the new design and will be the only place in which the product is in direct contact with the user. The mouth piece will need to be designed so it can be taken off cleaned and then placed back onto the product. The mouth piece's other consideration is that it needs to be comfortable for the user. Just like instrument mouth pieces the size will have to suit the user and the product.

The mouth piece will be made from a silicone material to allow the user to bite down and grip the product with their teeth.

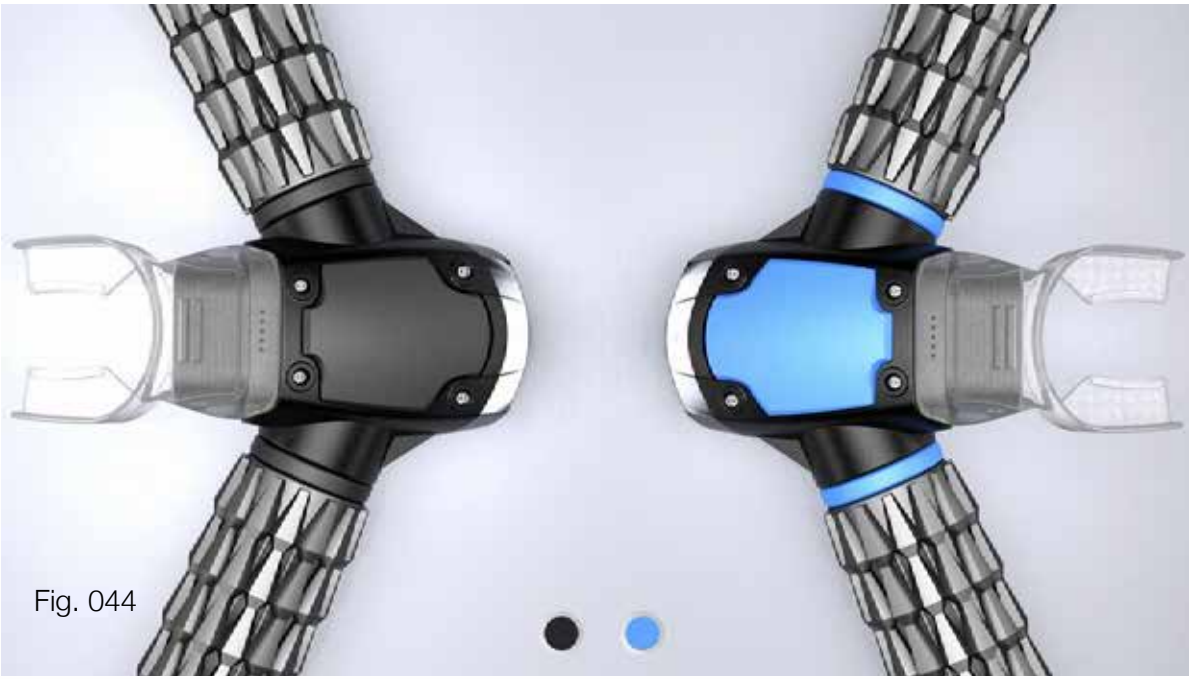


Fig. 044

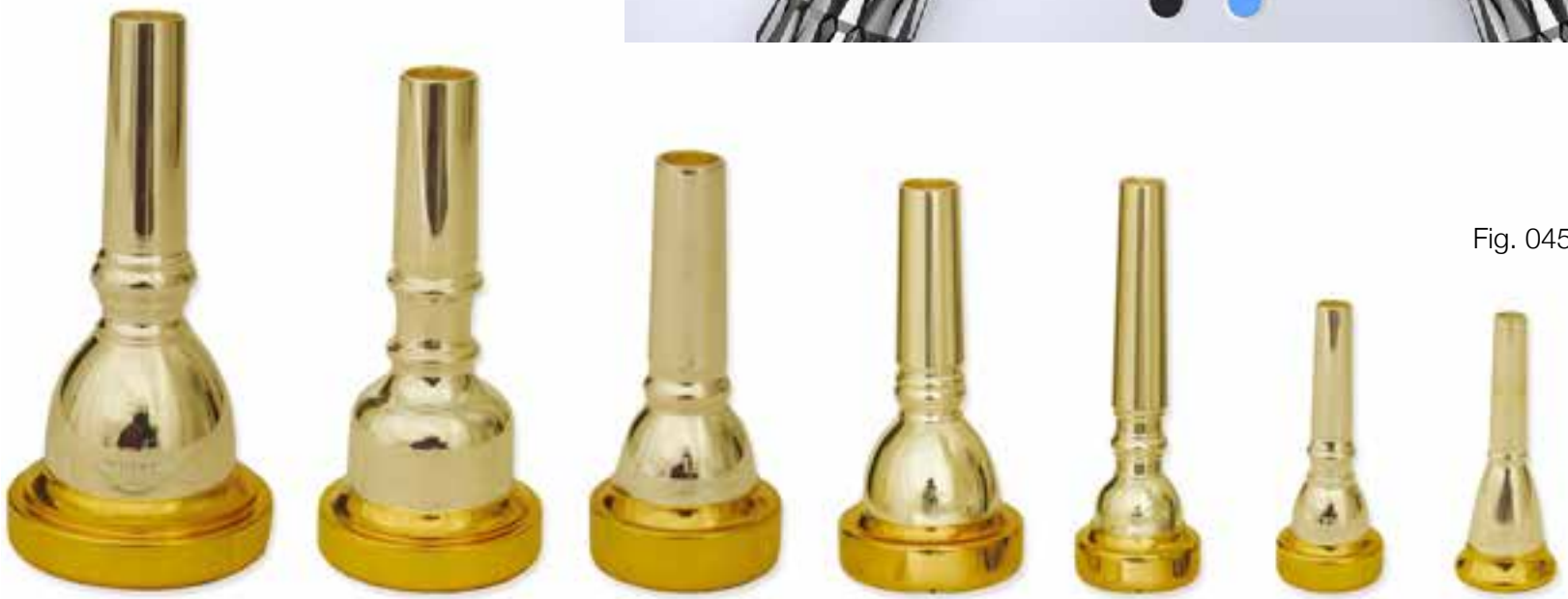
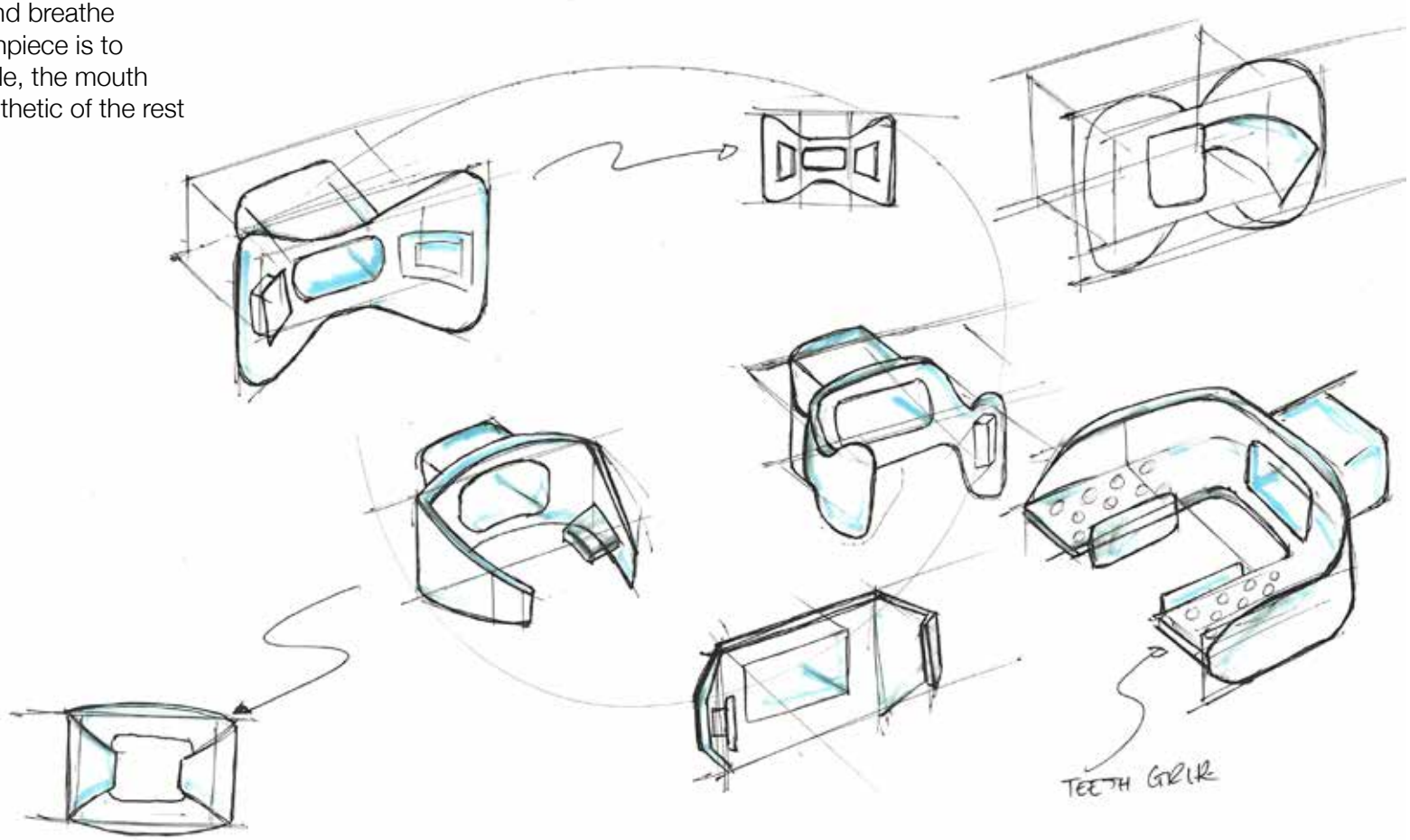


Fig. 045

Mouth Piece Concepts

A series of mouthpiece concepts were sketched to identify the aesthetic, how the mouthpiece would fit into the users mouth and breathe through it. The aim for the mouthpiece is to ensure the product is comfortable, the mouth piece should also match the aesthetic of the rest of the product.



Mouth Piece - 3D Printed Concepts

The mouthpieces were 3D printed from a flexible material so it could replicate the feel of silicone within the users mouth. The mouth pieces were tested for comfort, aesthetic, and structural integrity. All mouth pieces will require a supporting band around the edge to help support the mouth piece for the user. Mouthpiece C was the most comfortable mouth piece and the teeth pattern allowed users to grip the mouth piece. Mouthpiece C still needs some fine adjustment like the edges need fillets on to allow the mouthpiece to feel smoother in the users mouth.

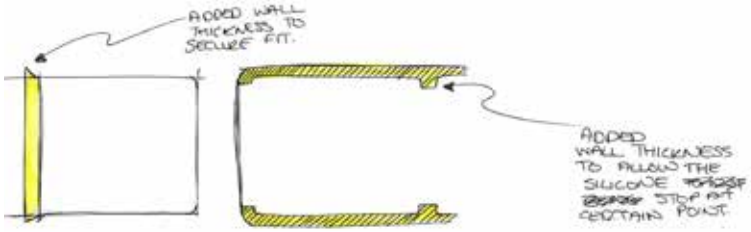
User Testing - Mouthpieces

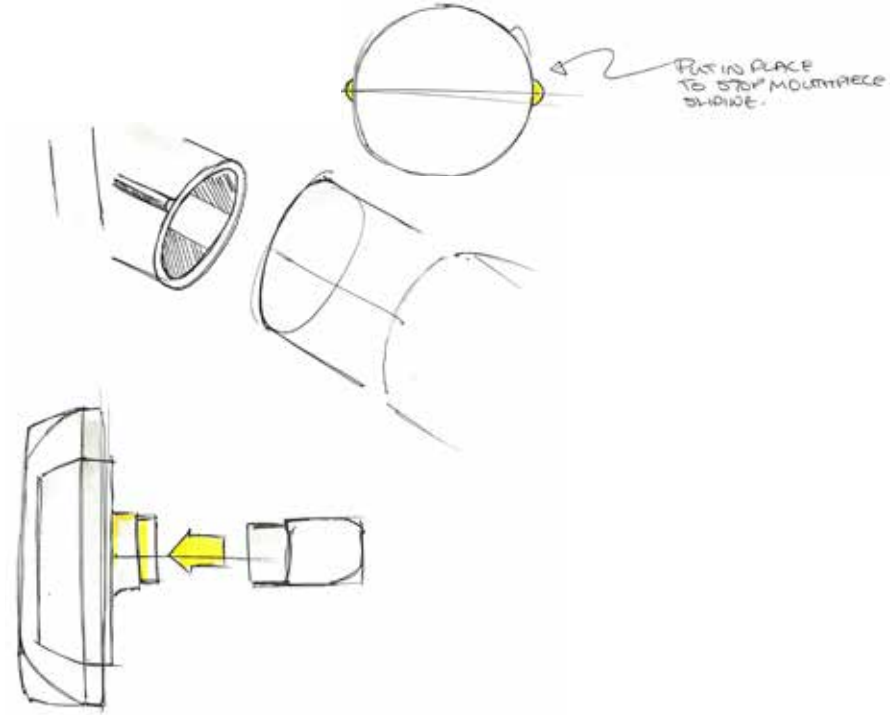
The mouthpiece were given to a number of uses to test two main things, aesthetics and comfort.

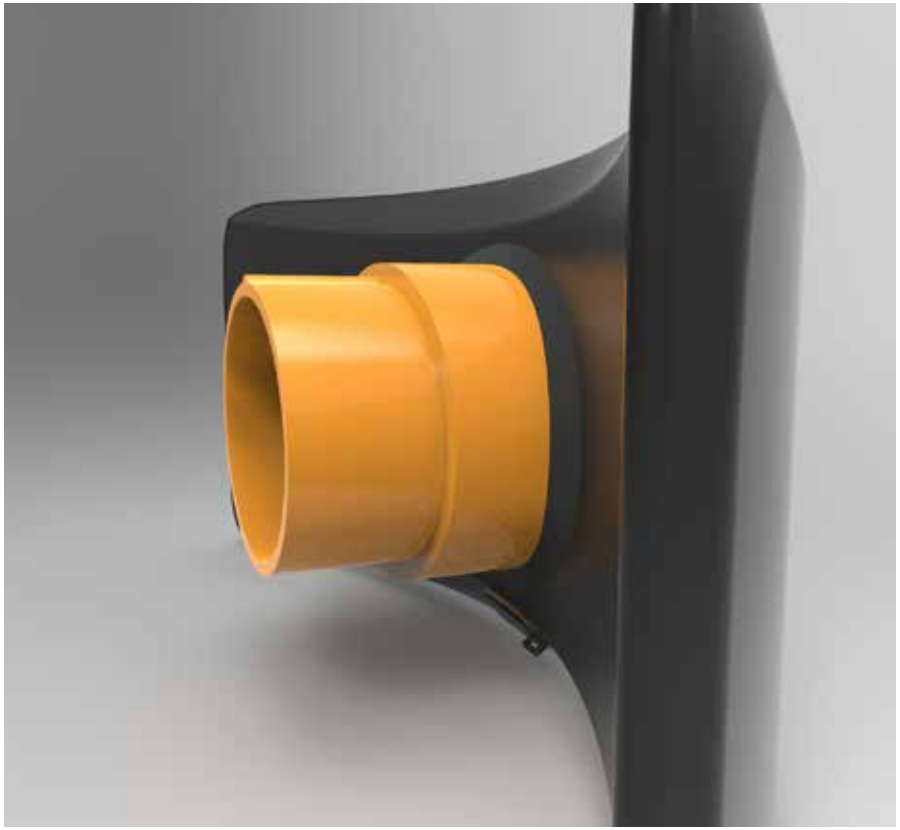
This mouthpiece was selected to progress forward with the dimensions. The aesthetics will still need to be developed to appeal to the target user.

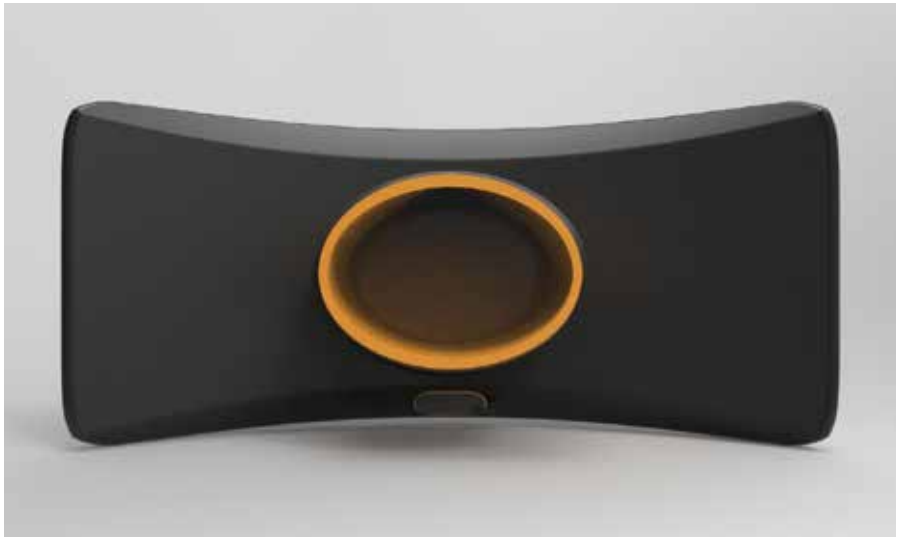
Mouth Piece - Development

After the prototypes were made a lot of changes were identified that needed to happen. The mouthpiece would no longer have a circular face when it comes into contact with the product. Changing the shape to an oval or rounded rectangle will stop the mouthpiece from rotating and allows the mouthpiece to always sit in the correct place. The visual language of the mouthpiece will need to be developed to suit the aesthetic of the rest of the product.

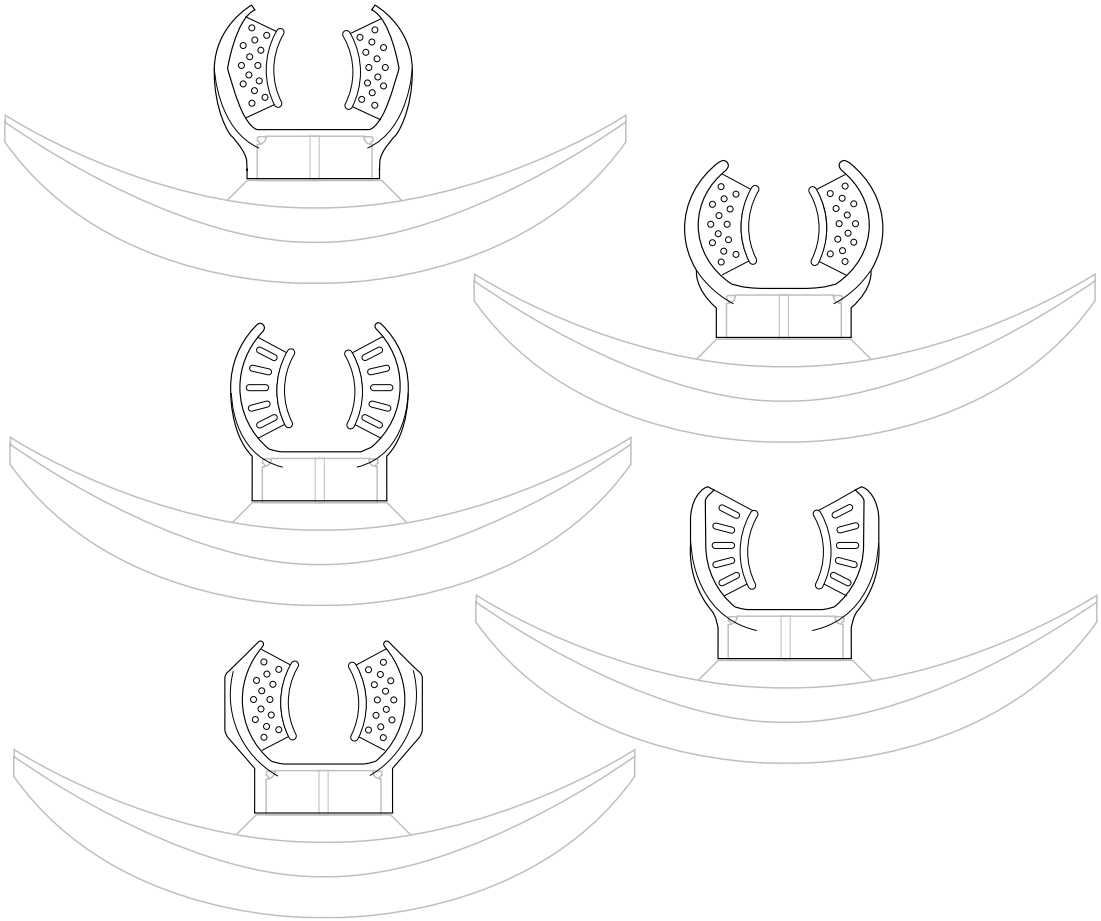






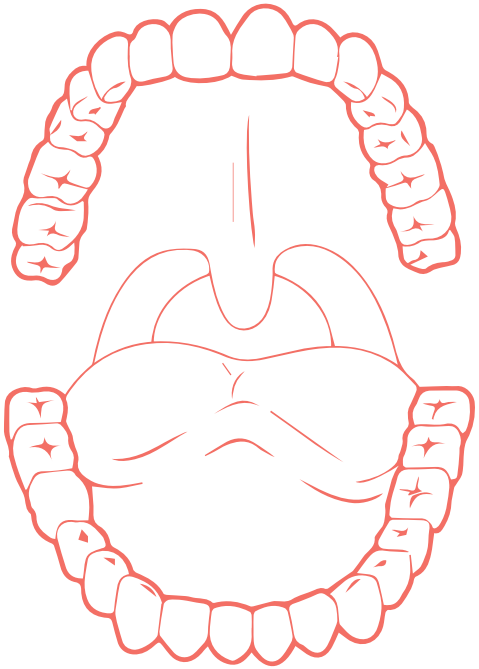


The design of the mouthpiece was developed in response to the text on the previous page. Where the mouthpiece meets the product will now feature an oval shaped design that will also have a slight notch in the top. This will allow the design to not rotate when in use. The medical grade silicone mouthpiece will also feature some teeth grips within the design.



Mouth Piece - Development

The mouthpiece under went some ergonomics testing after it was 3D printed. After the dimensions of the mouthpiece were decided upon to suit as many consumers as possible the last thing was to suit the aesthetics of the rest of the product. The only other aspect left for the mouthpiece to be decided on is the teeth grips. On this concept to the right the teeth grips use a straight slot linear pattern however, in the final concept the teeth grip will follow the same pattern as the surface texture on the back face of the product.



Mouth Piece - Hygiene

Due to the mouth piece being in the users mouth for around 2-3 minutes, the aim for the mouth piece is to be as hygienic as possible. The mouthpiece will be molded from a medical grade silicone that on a material level will avoid bacteria growing on the part.

However the mouthpiece will still need to be cleaned after it has been used. The first enabling aspect to cleaning the mouth piece is that it can be detached from the rest of the product to enable the user to clean it.

After researching how mouth guards are meant to be cleaned this left the mouth piece silicone a few cleaning methods.

Method One - Toothbrush and Toothpaste

Telling the users to use toothbrush and toothpaste could work as a good method for the users to clean the mouthpiece. However, the biggest issue with this is that this could quite easily scratch the plastic, leaving small scratches for bacteria to grow. (Christopher, 2014)

Method Two - Dental Sanitizing Devices

These devices work by placing a mouthpiece into the device under water and then utilising UV light and vibrations to clean the mouth piece. This is a good method of cleaning, however this is a totally new product in itself, and would add unnecessary cost to the product. (Christopher, 2014)

Method Three- Cleaning Tablets

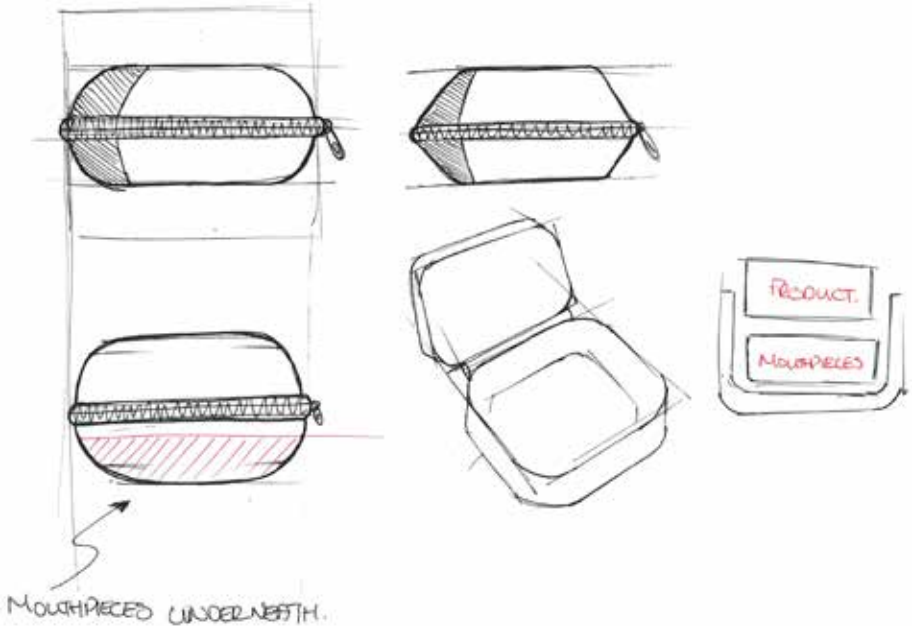
The chosen method for mouthpiece cleaning is dental cleaning tablets. When purchasing the consumer will receive a complimentary pack. By simply placing the mouthpiece in water with the cleaning tablets will remove 99.9% of bacteria after 15-20 minutes and will cause no damage to the silicone. (Christopher,2014)

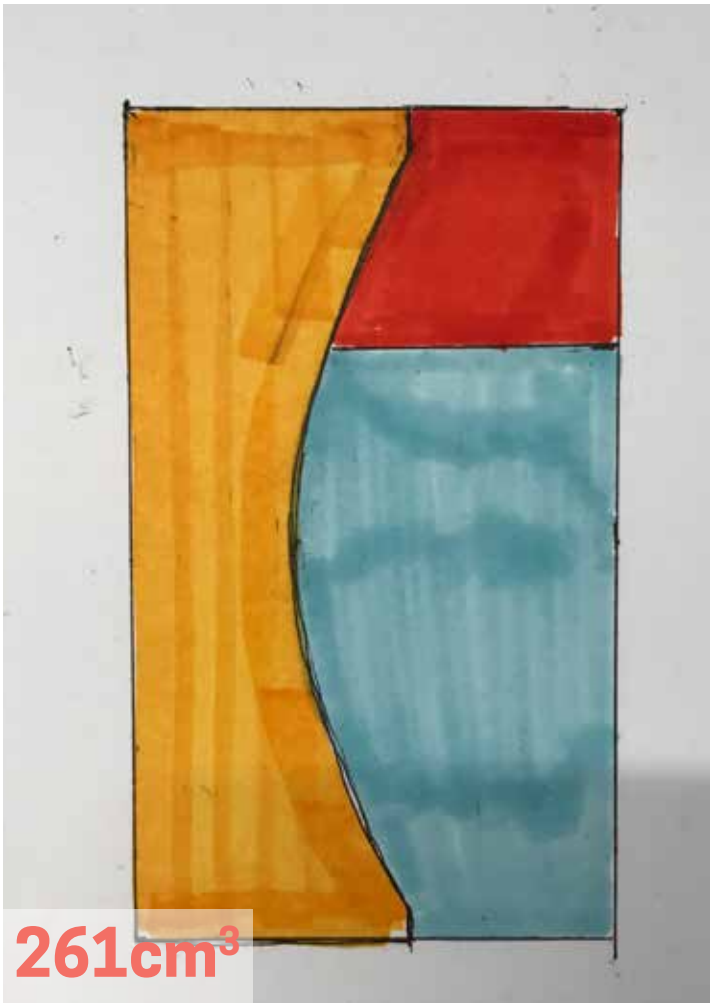
Fig. 046

Carry Case - Hygiene

The mouthpiece will come within a carry case when the user is transporting the product. Maintaining the hygiene for the mouthpiece is vital. Within the carry case will feature the product, the mouthpiece, the nose clip and a mini USB Charging cable. The carry case will be designed to fit all of these separate components within it to allow the user to keep every aspect of the product together, when transporting to gyms etc.

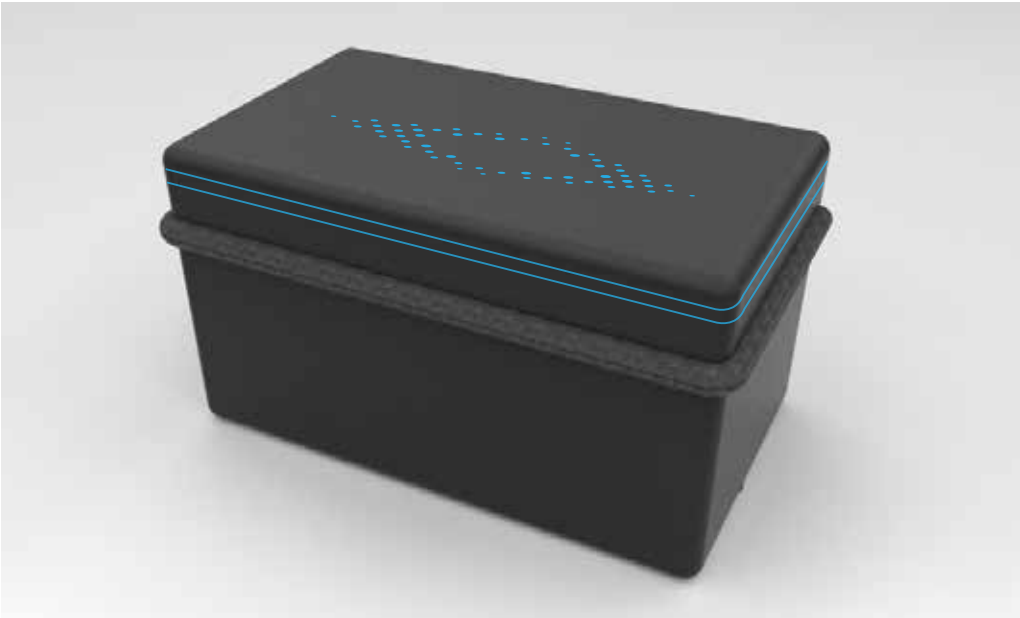
A number of concepts for the carry case were sketched and developed to envisage where everything will fit within the case and how the mouth piece will remain clean. A test was done using models to create a case with the smallest cm^3.





This layout was selected as the most suitable solution for the carry case. The main reason because it allow the case to take up the smallest volume. The product will sit along the back of the case, the mouthpiece on its side at the front to allow the user to easily pick it out of the carry case. The top right section is where the nose clip and Mini USB cable will be stored.

Carry Case - Hygiene



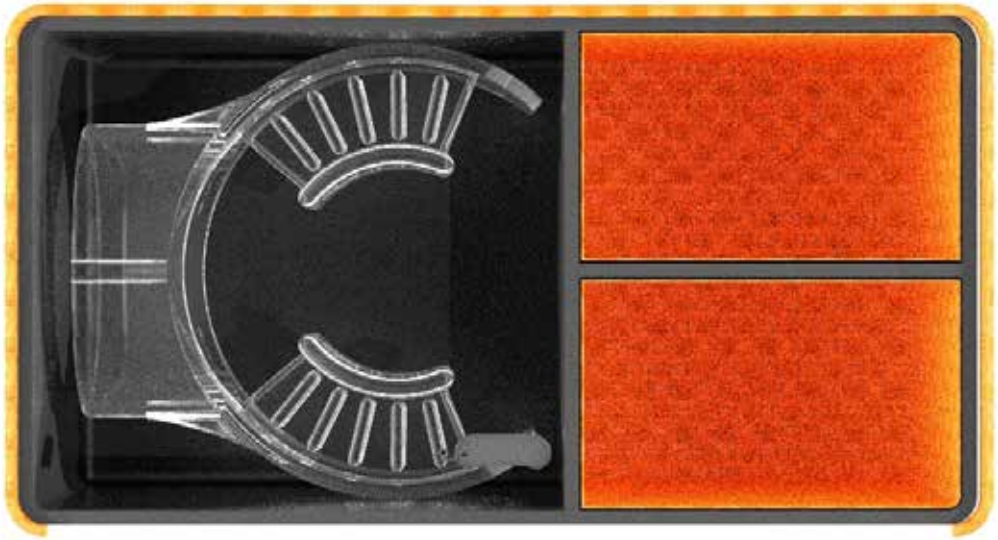
The carry case concept to the left shows how everything will fit into the carry case. The case will be manufactured from the same material as a sunglasses case meaning the design will be a EVA (Ethylene-vinyl acetate) vacuum formed container that would then be wrapped in a Nylon surface covering. The internals will then be lined with a velvet black material to allow the product to not scratch. The case would then be held shut with a zipper and hinge on a nylon elastic material hinge.

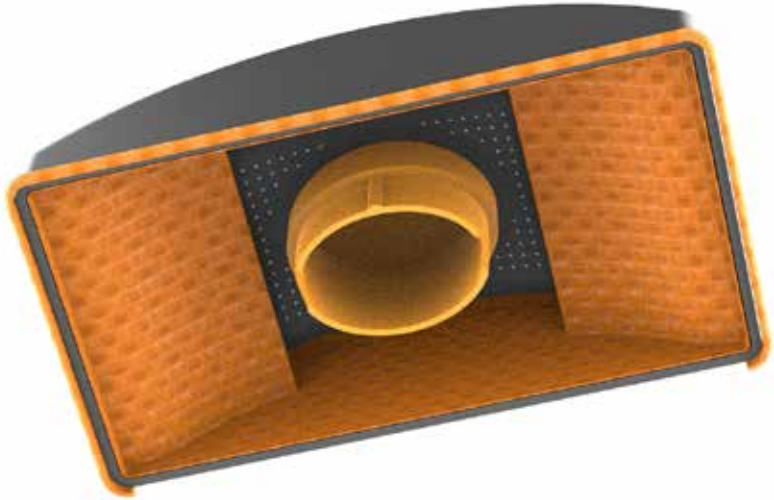
The other important aspect to the carry case is the inner case for the mouthpiece. This polypropylene box will in-case the mouthpiece opening and closing using a live hinge. This polypropylene box can be taken out and washed just like the mouthpiece.

Carry Case - Form Refinement

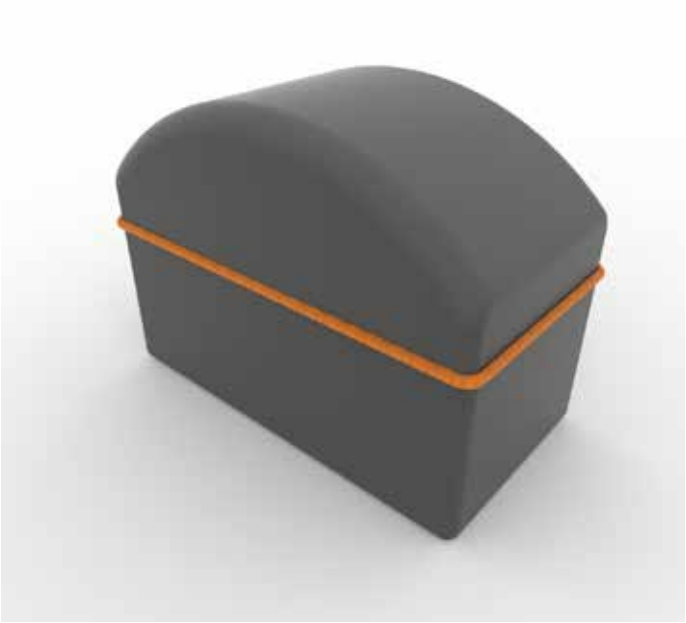
Although the carry case could comfortable fit everything required the form was still too big. The carry case has a primarily focus to fit everything in the user requires however, the carry case still needs to be compact as it is very likely that the case will be carried with the user so reducing size will improve the usability of the whole product.

The first carry case on this page looked at packaging everything within in a different orientation to try and fit everything in a smaller method. However, the results were still not ideal with carry case being too large. This carry case was still too large and still needed form refinement, but the form was beginning to emit the products and the brands visual language.





Product stored into top half of case using two sewn in sleeves that trap the product into the lid of the carry case.



Carry Case - Form Inspiration

The carry case was still too big and not desirable enough for the product. Some inspiration was gathered looking at packaging and other product carry cases to try and find a suitable aesthetic for the form. After this some more sketches were constructed to build on this inspiration.

Fig. 048

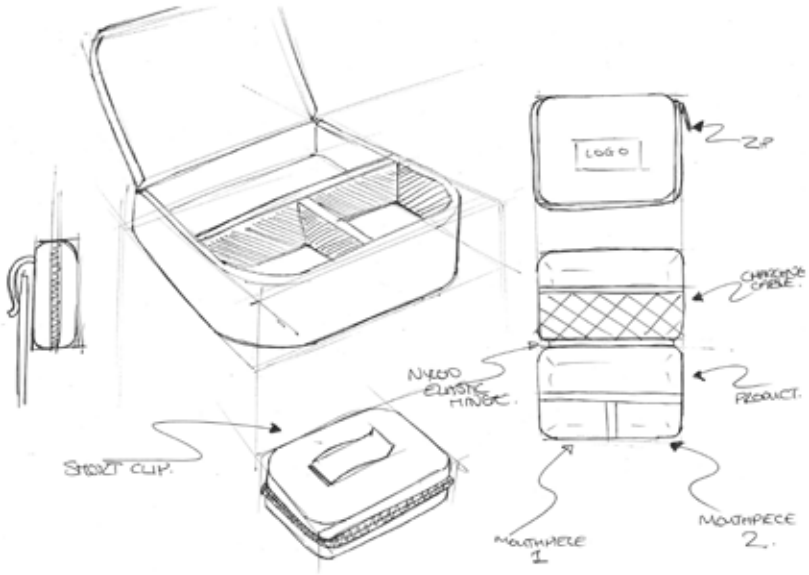
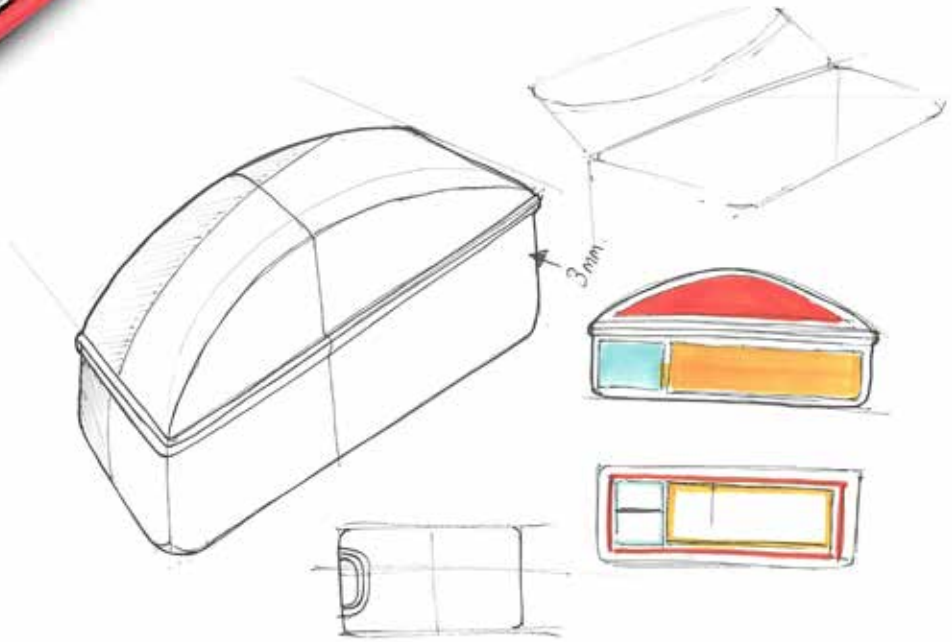
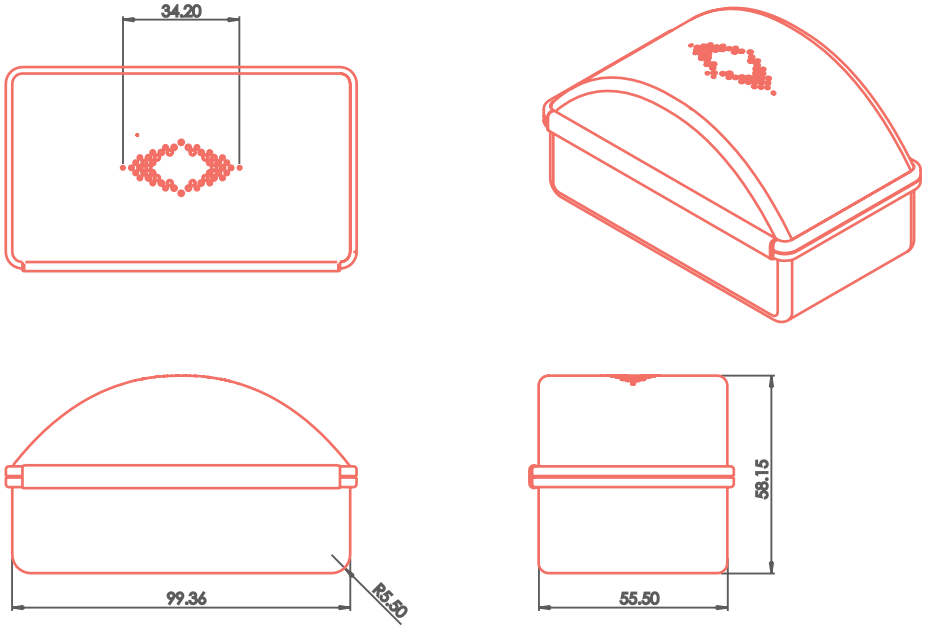


Fig. 047



Carry Case - Final Form

The carry case's final form is similar to that on the previous page however, due to a revised packaging method the final form is a lot smaller. The product now sits inside of the mouthpiece in perpendicularly. This allows the form to be more compact for the user to transport around with them.

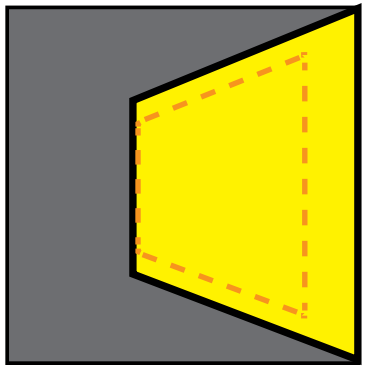


Form Model

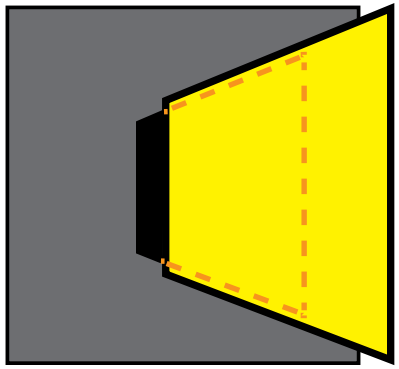
Resistance Slider

On the original face mask concept the resistance of air flow was coming from the resistance air caps. However, within the developed concept the resistance method has been re-thought out. The idea is now using a resistance slider. This allows the user to simply slide the resistance adjustment outwards to adjust the amount of air flow available to themselves before the 30 breath workout.

The amount of resistant increments for the user to adjust the resistant sliders has been thought about for a while. The resistant increments earlier in the project had eight different variations, however after looking at other resistance products the resistant increments they use has been found to be around four increment sizes. The resistant elevation mask uses four increments for the user.



Closed Air Flow

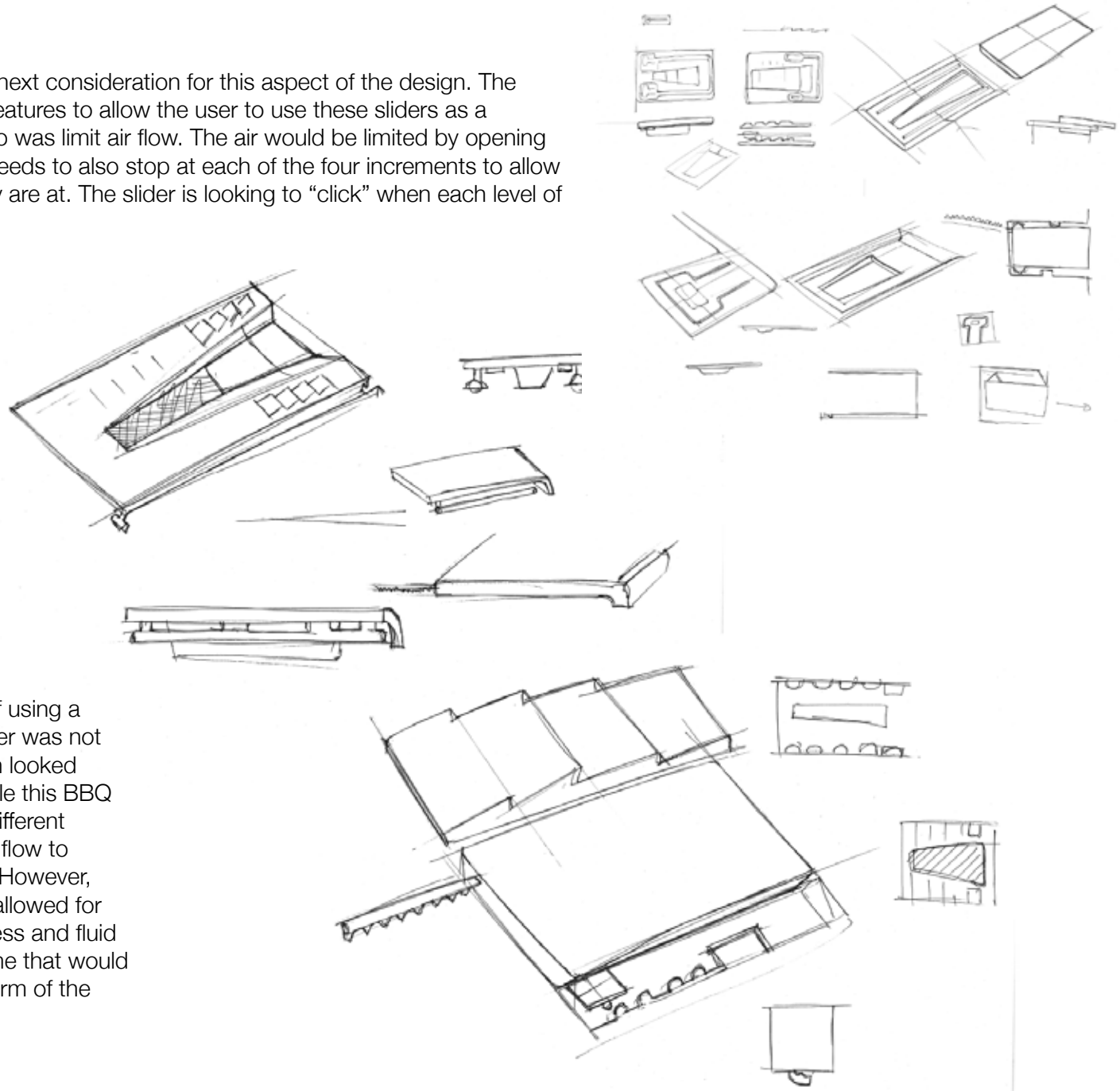


Open Air Flow

Fig. 049

How the resistance slider would work was the next consideration for this aspect of the design. The resistance slider had to undergo a number of features to allow the user to use these sliders as a resistance feature. The first thing they had to do was limit air flow. The air would be limited by opening and closing the inspiratory air gap. The slider needs to also stop at each of the four increments to allow the user to identify what level of resistance they are at. The slider is looking to “click” when each level of resistance increment is changed.

The method of using a resistance slider was not the only option looked into for example this BBQ hood uses a different method for air flow to be controlled. However, using a slider allowed for a more seamless and fluid design outcome that would also suit the form of the product.

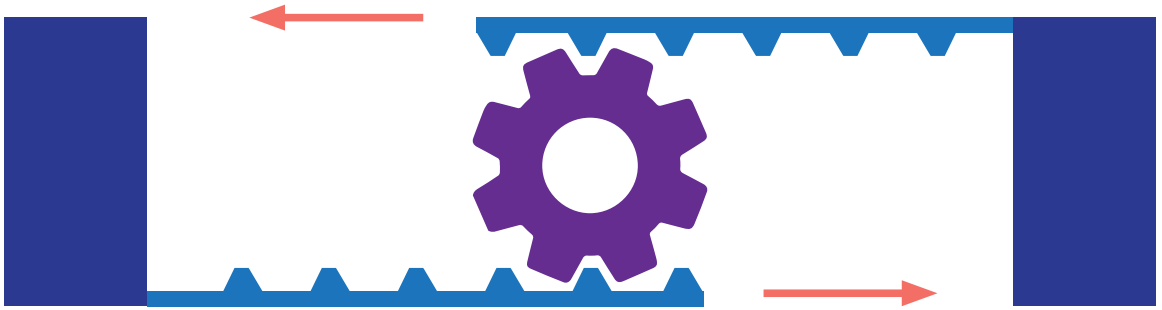


Resistance Slider

Due to the design featuring adjustment sliders for the resistance levels on both sides of the product. This is due to aesthetic reasons and also allows the user to adjust in a more ergonomic method due to the resistance sliders being placed on the side of the product.

However, one issue would be is adjusting one side and not matching it up with the other. Causing unequal resistance levels for the user will cause issues when the product is in use.

Taking inspiration from printers pictured right and bike helmets adjustment will allow the resistance to be adjusted on one side and the other. The bike helmet example pictured to the right also uses the same mechanical adjustment.



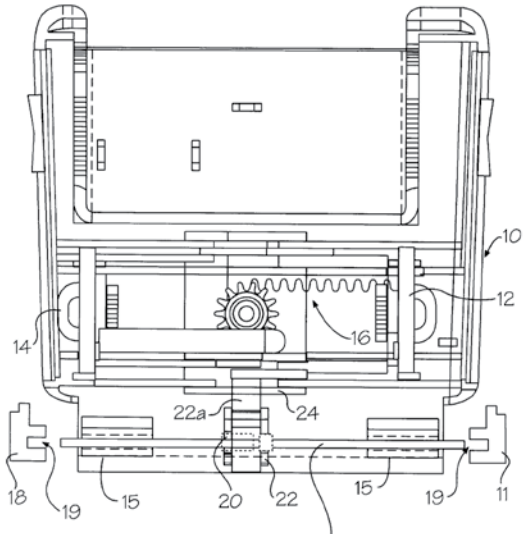
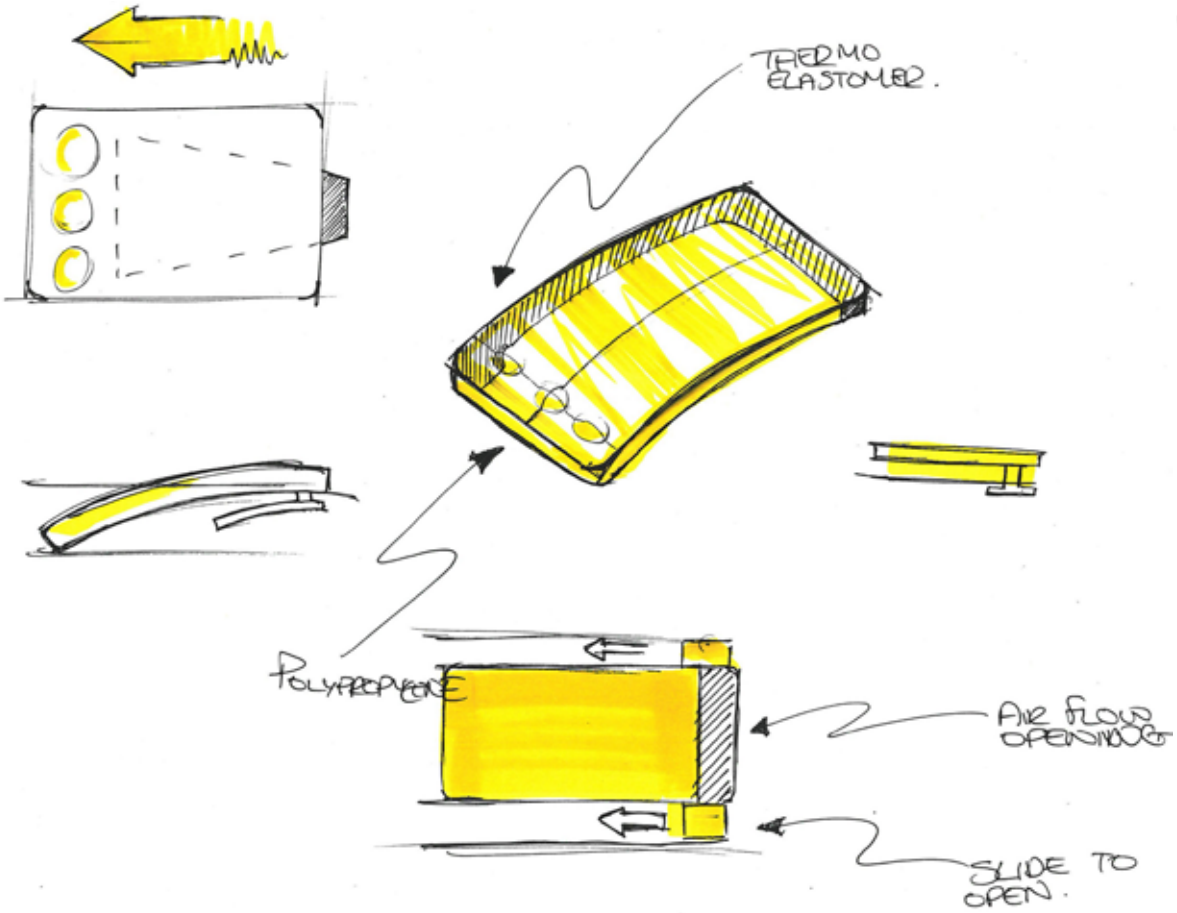
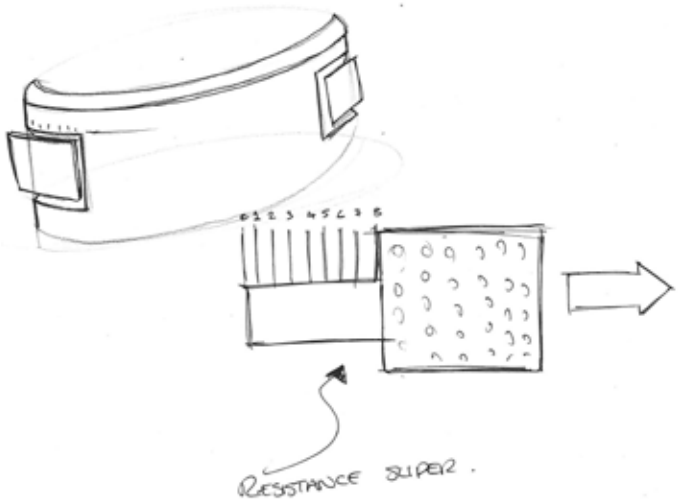


Fig. 050

Resistance Slider

The resistance slider is a big interaction point for the user so ensuring the adjustments have good touch points and our easy to understand is vital. The resistance sliders may end up using a graphic as well to guide the user through the adjustment process.

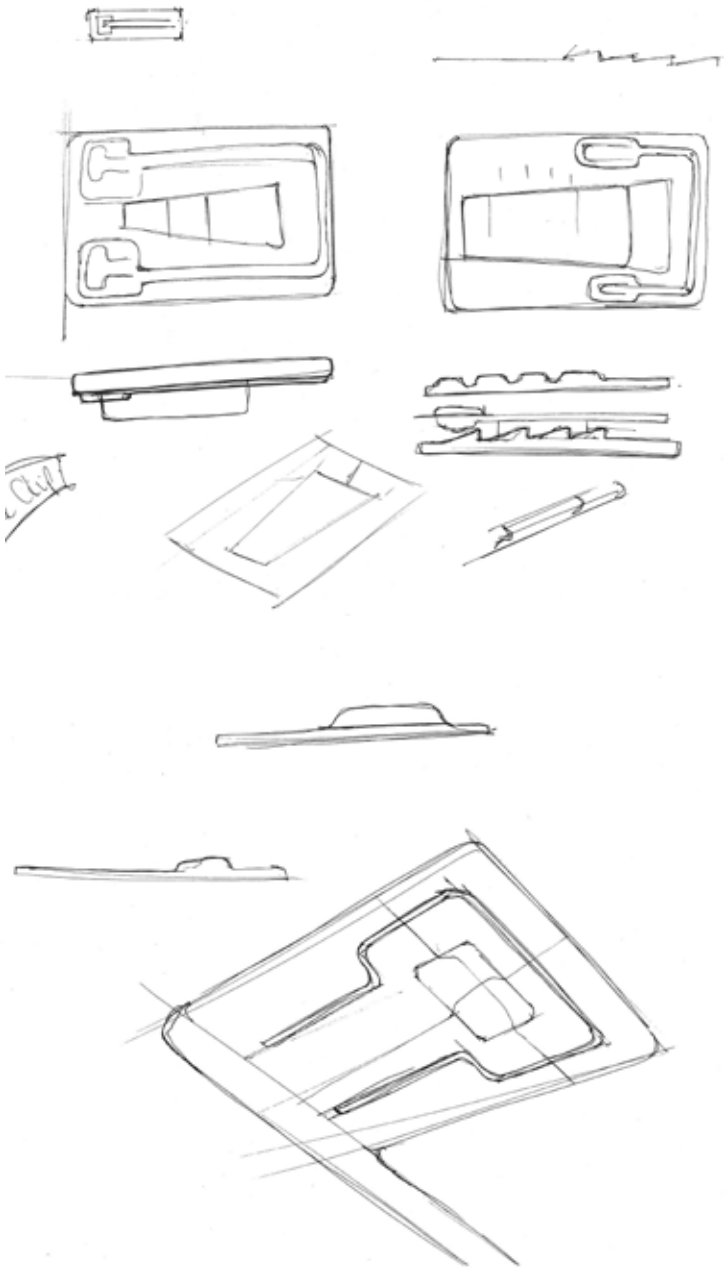


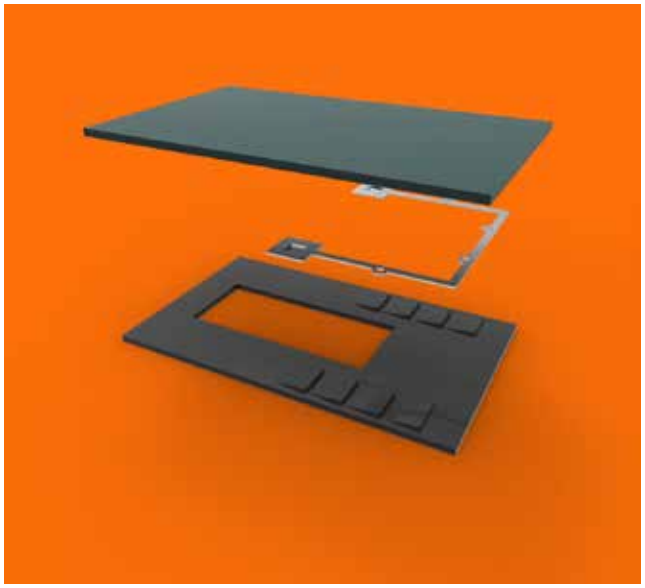


Resistance Slider

The resistance slider will need to give the user feedback so they can easily identify what level of resistance they are about to exercise with. Although this will be done with the graphics on the front face of the product the aim is to allow the adjustment to have some tactile feedback when the user interacts with the product.

The method this will work will use an aluminum insert. The aluminum inset was taken from a pair of Urban ear headphones, the stamped aluminum piece has a raised section that when enough pressure is applied allows the headphones to move up or down and adjustment level. This work in conjunction with the plastic molding that allow the adjustment levels to be obviously felt by the user.



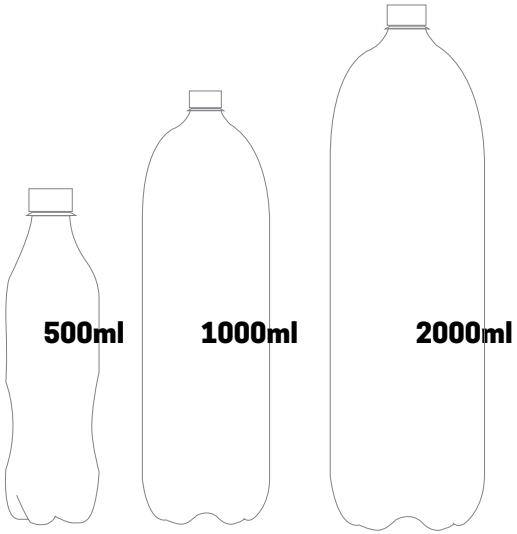


Tidal Volume

The Tidal Volume of a person is a term used to describe the normal volume of air displaced per breath between normal inhalation and exhalation when extra effort is not applied. The average tidal volume for an adult individual is 500ml (TeachPE, 2016).

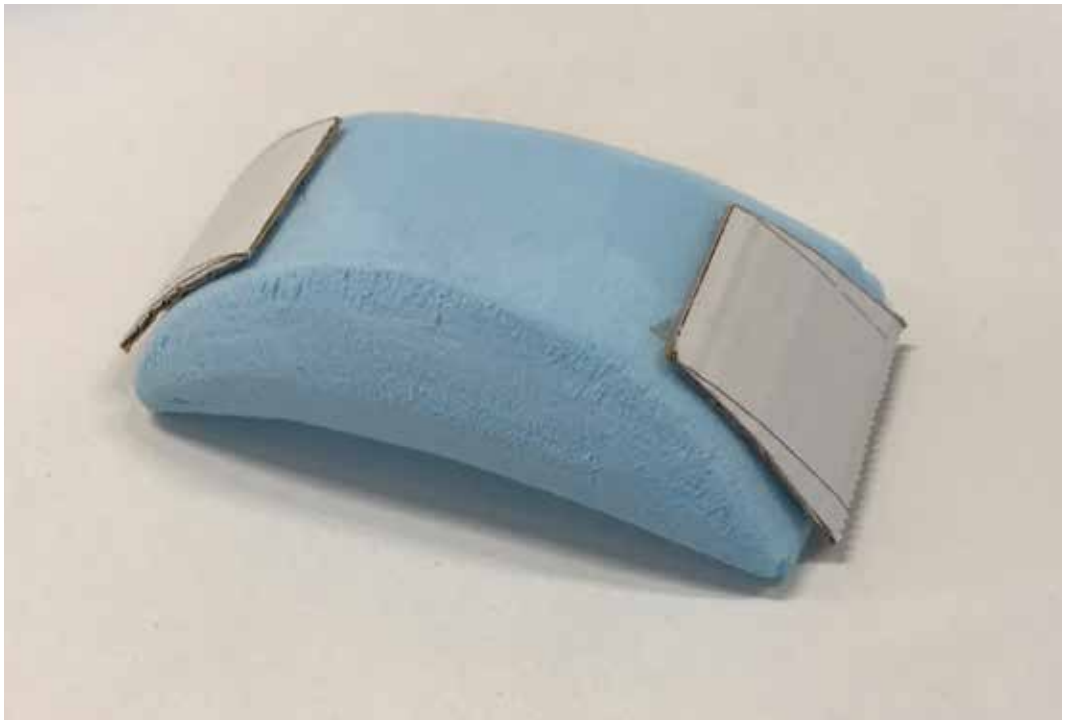
As expected the Tidal Volume of a person will increase during exercise (Livestrong, 2015)

The tidal volume of a user has been looked into to identify how much physical space (cm^2) is needed within the product for the resistant increments. Its been discovered that within sport a users tidal volume can reach 1000ml of air and with some extreme athletes reaching a tidal volume of 2000ml.



A resistance slider was made to replicate the resistance within the mouthpiece. This allows the user to slide the resistance slider. The model made formed an air tight seal when shut and helped replicate a resistance slider that will be featured within the mouth piece. The model was given to a user who stated that the resistance between each increment could easily be identified when it was harder to breath through the mouthpiece and when it was easier.

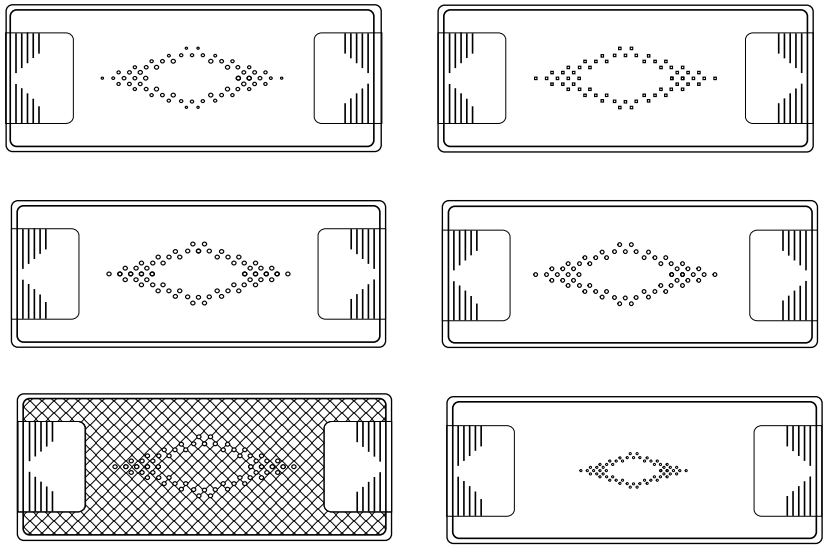
Developed Form Modelling



The concept was already decided that it was too harsh and aggressive. The other two iterations were taken inspiration from the first model to identify whether a big chamfer on the top could allow the design to still be portrayed as a high end product. The picture above shows the form iteration although it still needs work. The current form above needs to be thinner to reduce the weight of the design and improve the aesthetic.

Expiratory Breathing Holes

The expiratory breath holes gave a chance for a graphical layout on the front of the product. The chosen was pattern was picked to emulate an expiratory breath in a 2D graphical layout. The GO wheelchair was another source of inspiration as it uses a pattern with expanding shapes to give the pattern a more dynamic element. The pattern was then taken and formed into shape using a variant of sizes to identify the correct size. The expiratory tidal volume also had to have enough space for the air to escape before any turbulence is caused within the product.



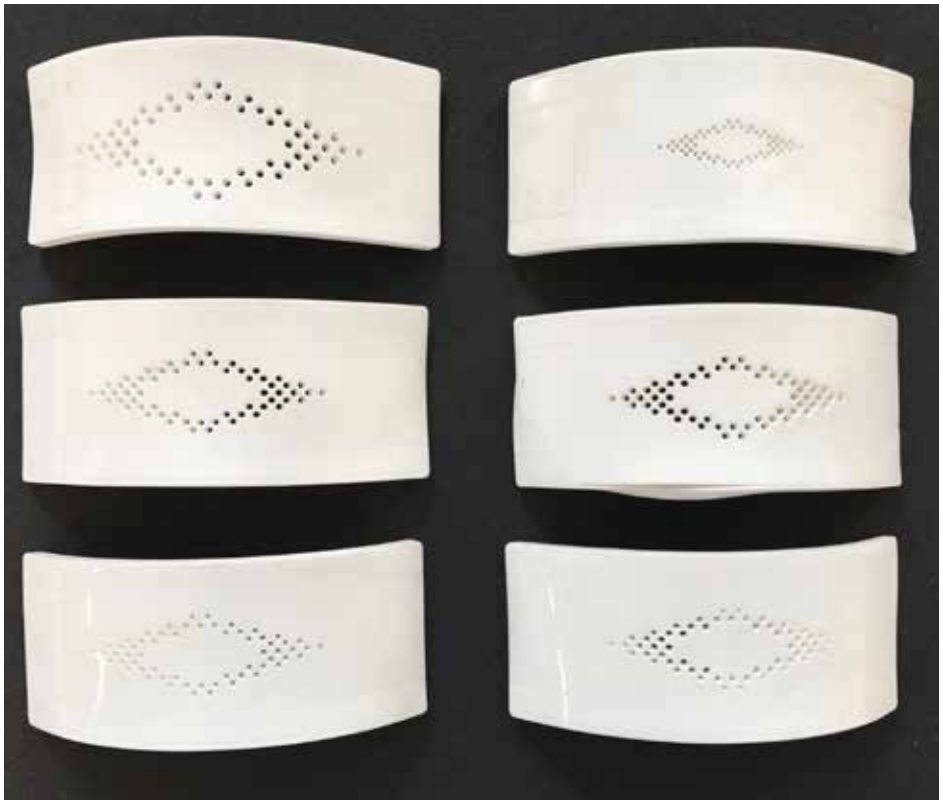
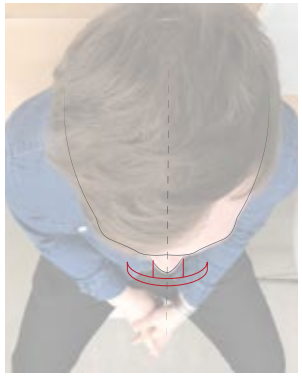


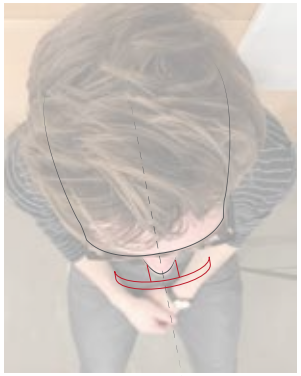
Fig. 051

Facial Footprint

The facial footprint of the product is a vital aspect to the design. How far the design extends from the users face also totally changes the aesthetic of the product. A number of increments were tested to identify the best solution aesthetically.

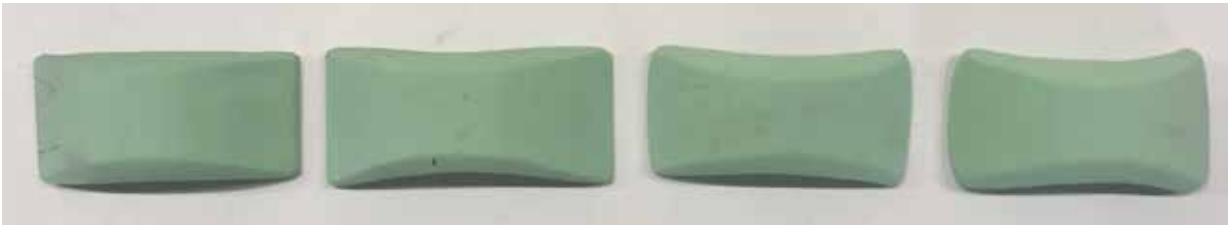
After this process it was found that 20mm will be the measurement between the mouthpiece and the back of the product. This gives the user enough space to comfortably move the product in and out of their mouth.





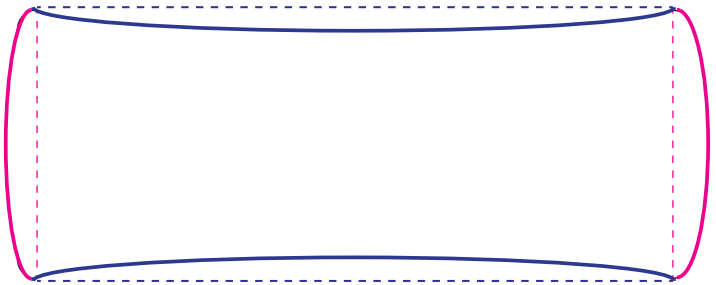
The curvature of the products form will also have a big influence on the aesthetics of the product. The first picture on the left was chosen as the top down footprint of the product.

Form Refinement

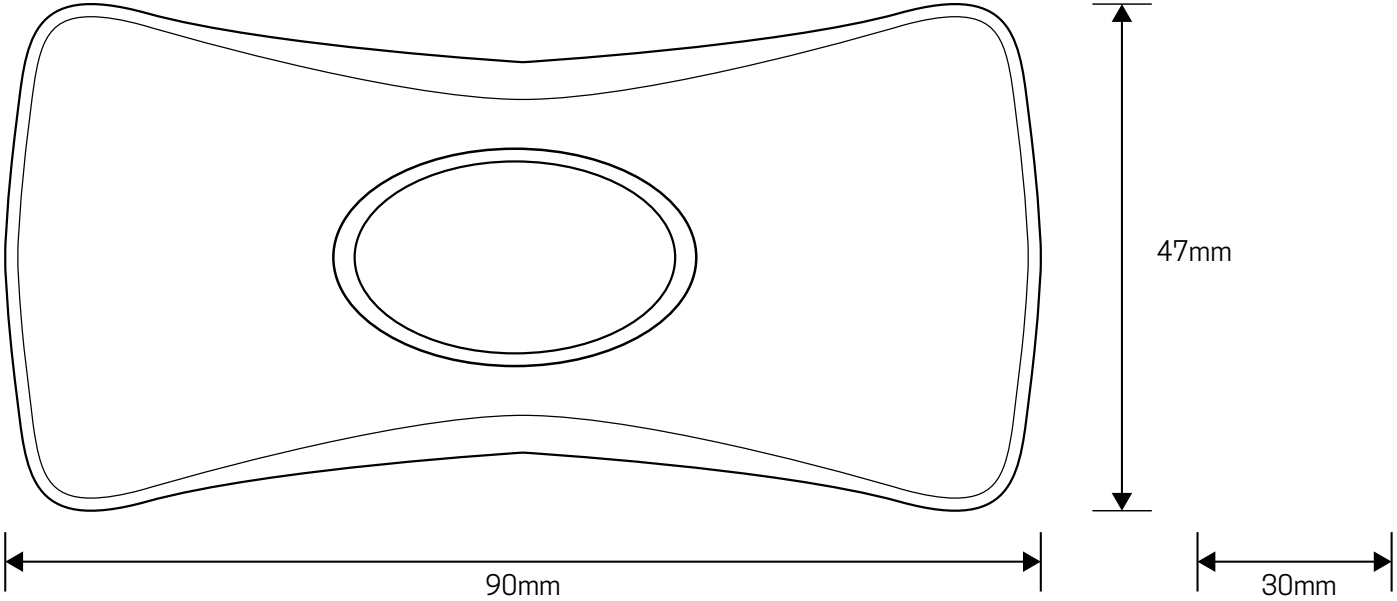


This process was done to look refining the final form for the product. The product was originally quite rectangular to change this fine tuning surface adjustments took place to soften the overall form of the product. The curve at the top and the bottom of the model was placed to allow the users fingers to fit in between the product and the nose and the side curves were put in place for aesthetic reasons.

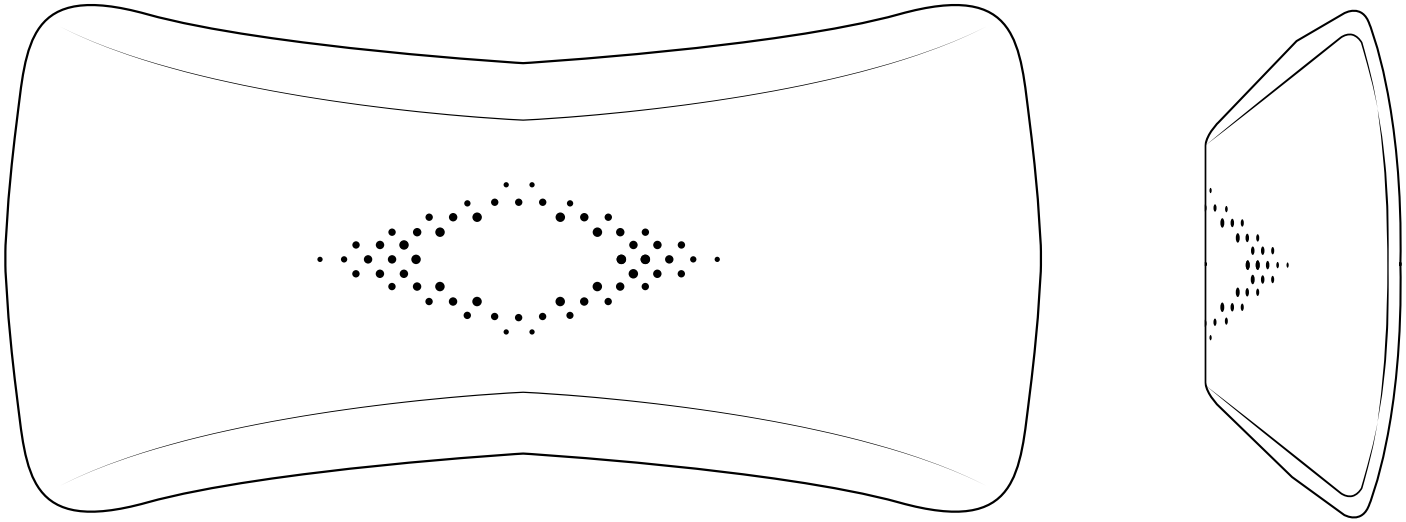
The third iteration has been selected for the final form of the product.



Final Form



The final form measurements are featured. The next steps will be focusing on the details and how this form can be transformed into a working product.



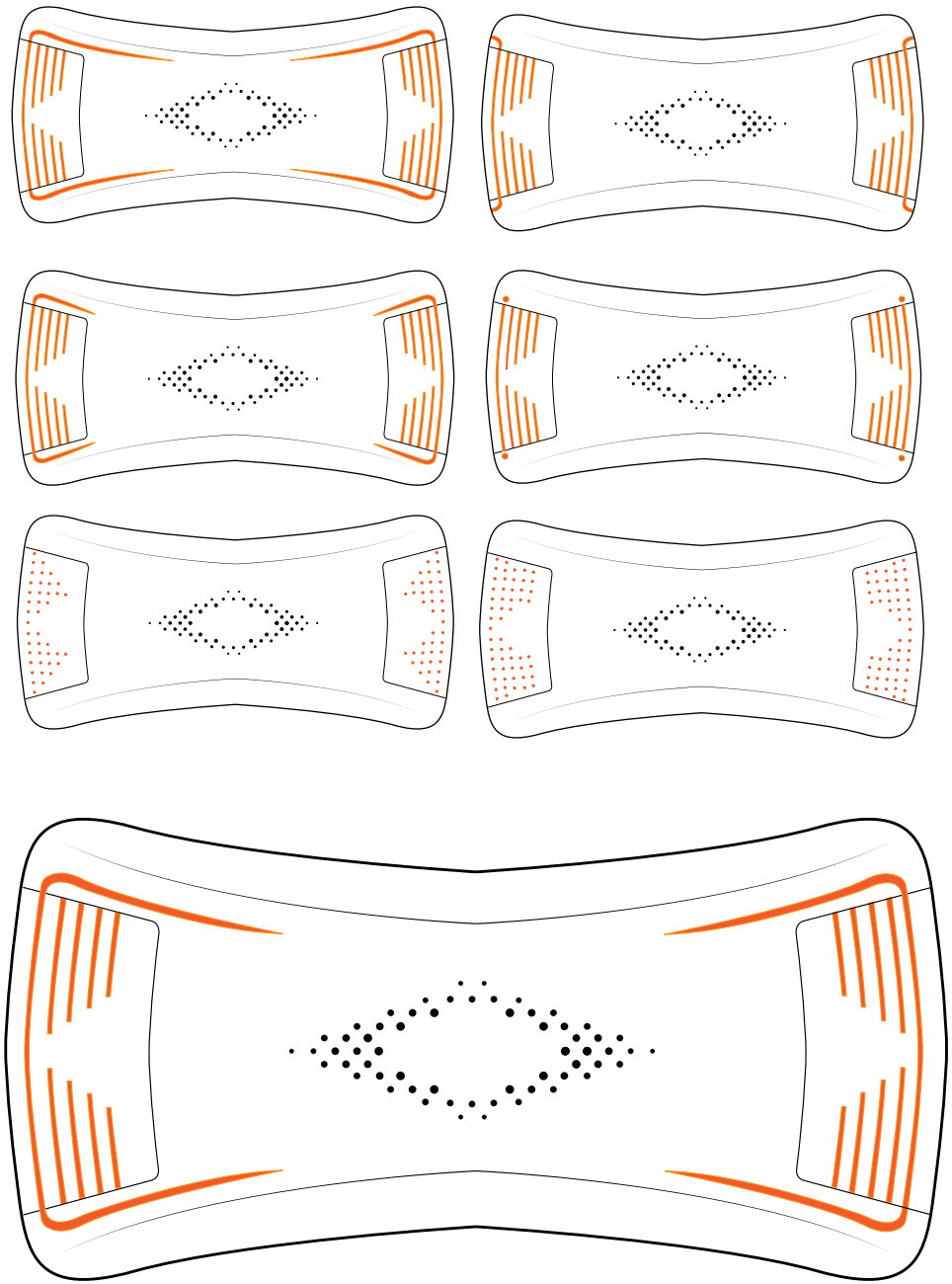
Resistance Graphics

The graphics on the front have been considered as they will be used so the user can identify the resistance level they are exercising at. A number of iterations were looked into to graphically show this adjustment. The orange has been used to show where the graphics would be displayed.

The final concept will take inspiration from the image shown below, the final graphics will contrast the body colour of the product either being matte and the body being gloss or vice versa.

As the resistance sliders move outwards they will line up with a new line. The bigger the gaps between the line is used to so it replicates the bigger opening for the air flow.


Fig. 052



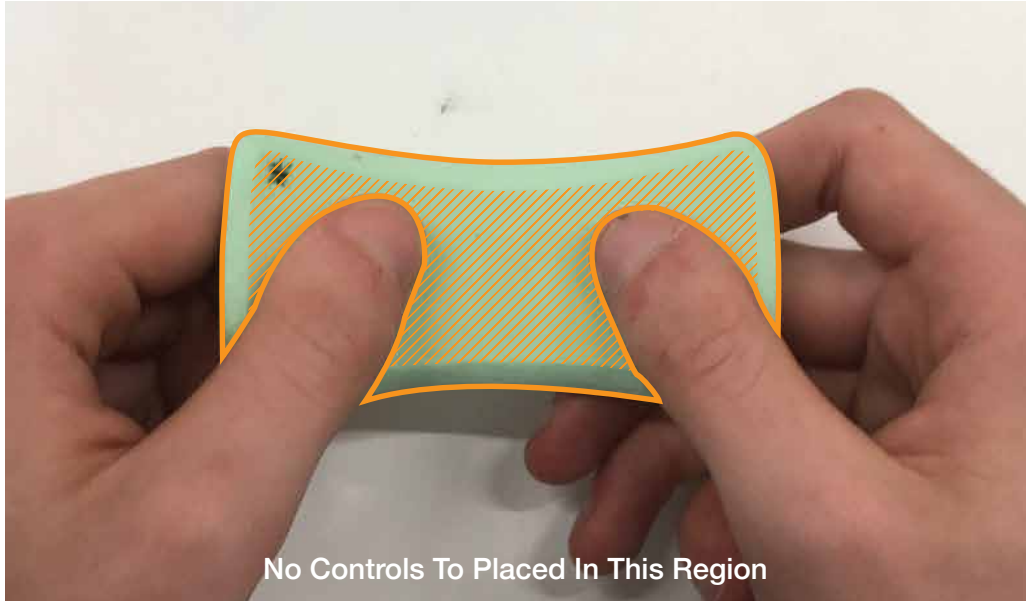
Electronic Controls Placement

Controls Required

- Bluetooth Pairing
- On/Off

The electronic controls needed for the product are not too complex due to the main interaction point within the design working at a mechanical level rather than electronic. The only electronic controls the user will interact with is the on/off switch and the bluetooth pairing due to the other necessary interactions rather than the mechanical ones coming from the companion app.

Where these controls are housed within the design will be an important interaction point for the user. The control placement needs to be easily accessible however, the controls can not be interacted with when the user does not require them to be or when the product is in the persons mouth.

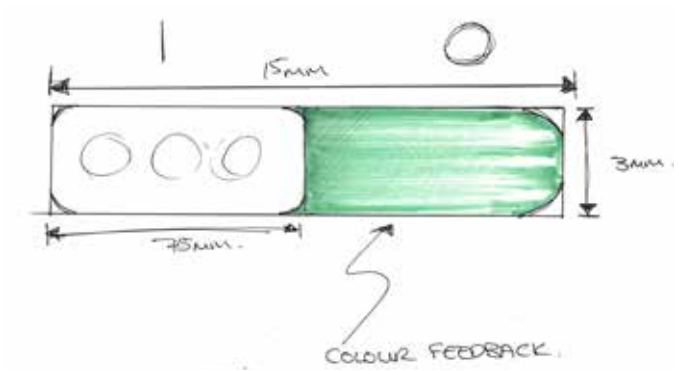


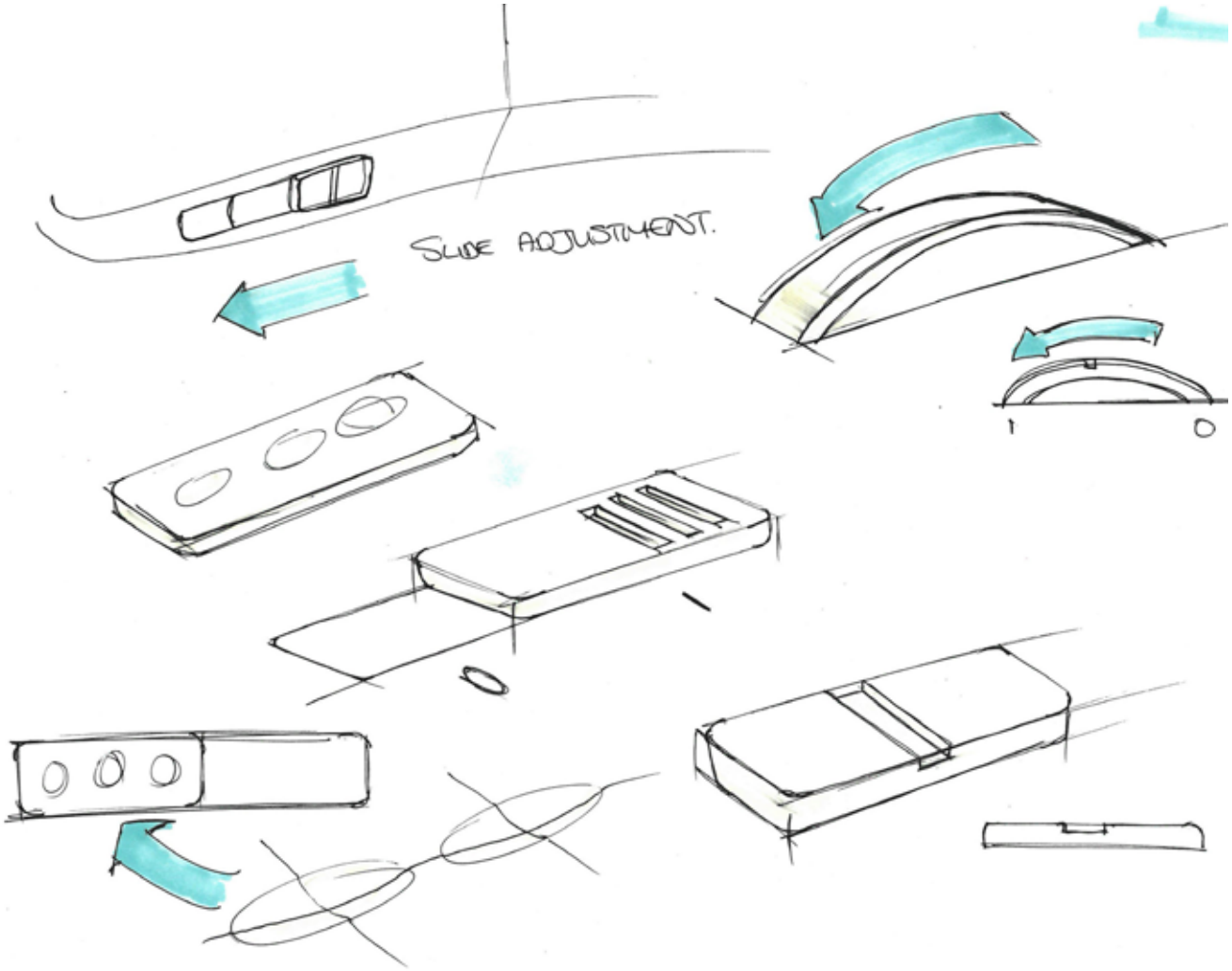
Power Control Design

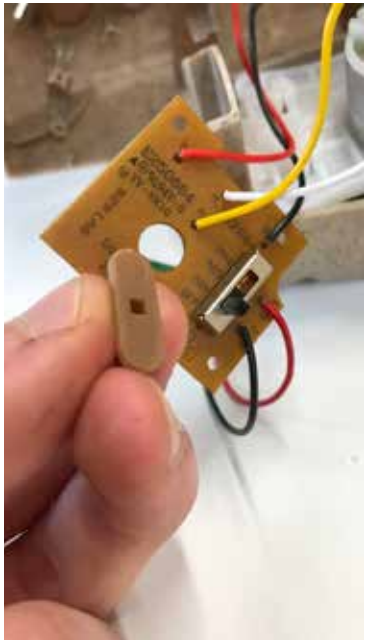
A number of concepts have been designed to look at how the product could be turned on and off.

One concept was looking at whether a pressure sensor could be placed onto the end of the mouthpiece adapter. Once the mouthpiece was placed on it would turn the product on. However, this would cause usability issues within the product.

Others looked at simple switches, whilst others were looking at fingerprint technology an or shaking the product to turn it on.

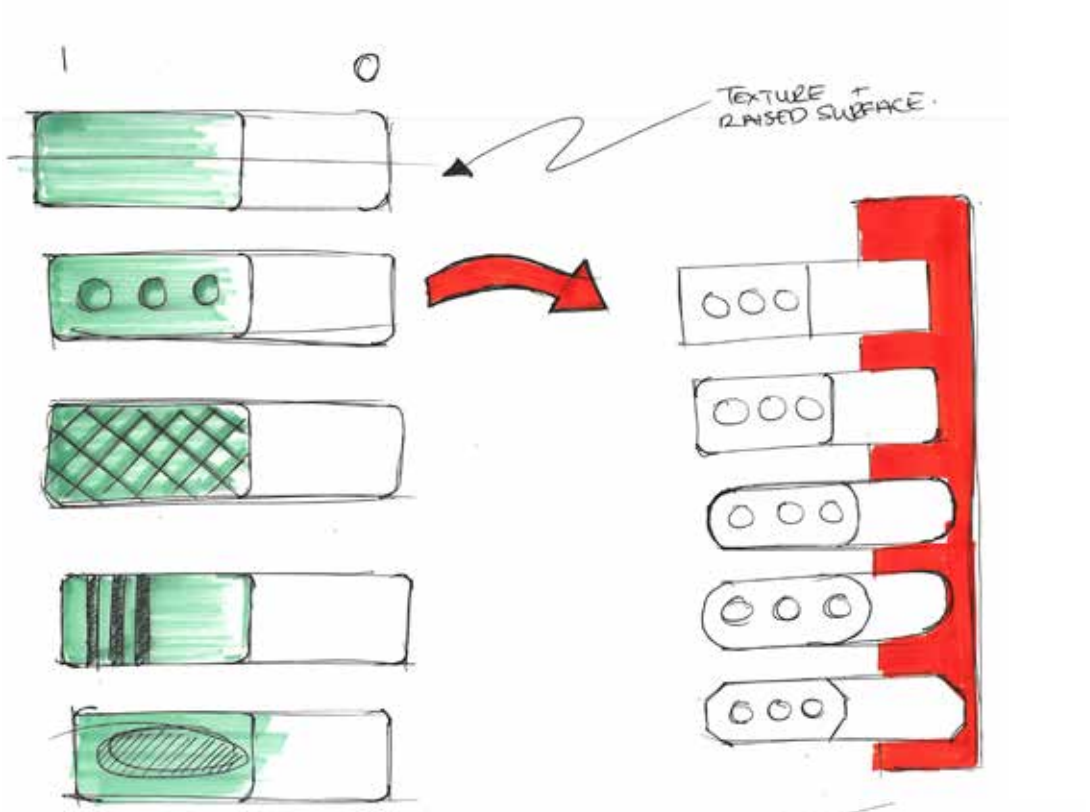


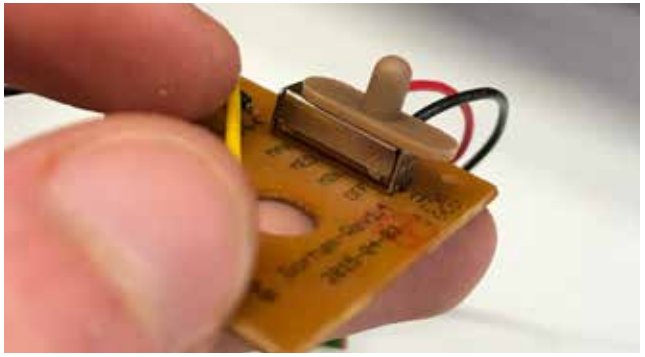


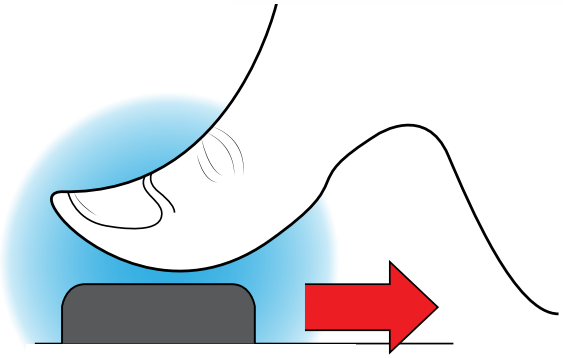


The power switch will work using a sliding switch. This is to allow the user to simply rest the bottom of their thumb to turn the product on and off. Due to the switch being very small, some texture will be added on the top surface of the switch to allow the user to grip when interacting with the control.

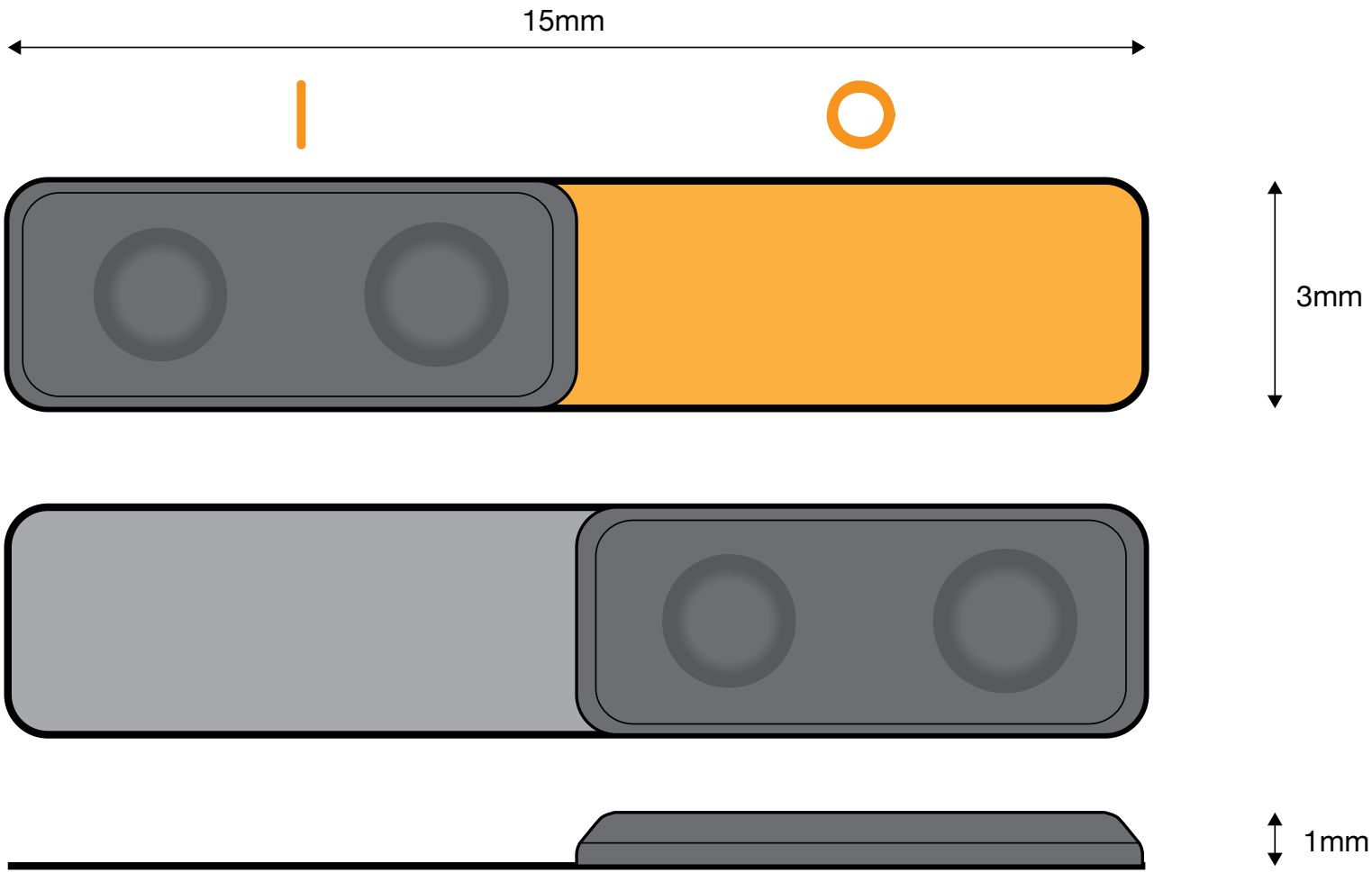
This control to the left uses a small sliding control. The outer housing fits on top of a micro switch that allows the user to slide the control, turning the product on and off.







The proposed power switch will not take up too much physical space on the product. To tackle the size issue the switch has an increased length to allow the action to have a more tactile quality. The switch will have two filleted circles that will also increase the surface area of the control. The raised and chamfered body to the switch has been designed in this way to allow the user to easily locate the power switch.



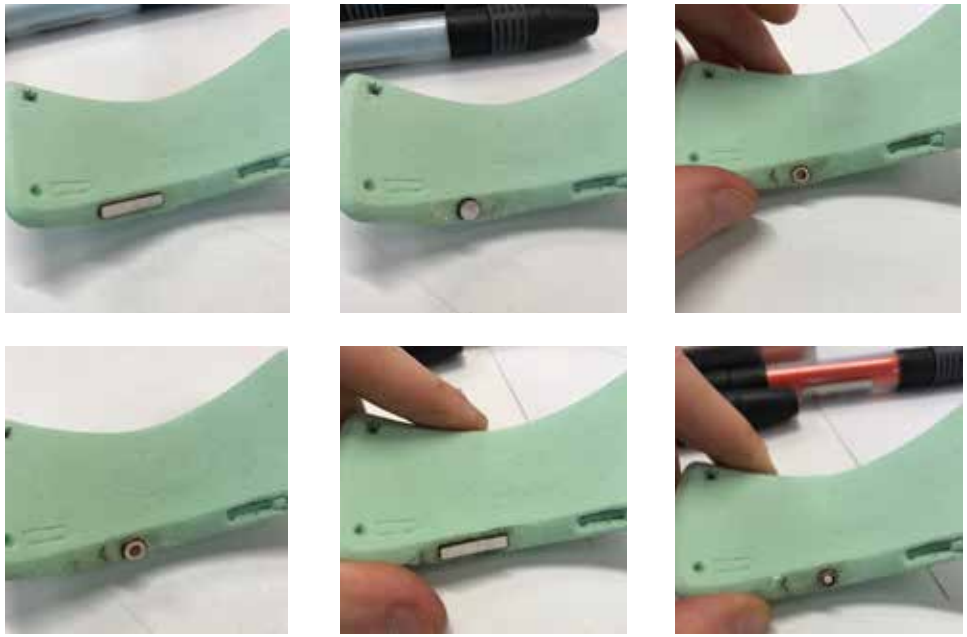
Bluetooth Control

Pairing the product is an important aspect to the design as this allows the user to utilise all of the features coming from within the app. The technology behind the bluetooth has be spoken about previously within the log.

The location of the bluetooth control will be along the same edge as the power control. However the control will look different aesthetically and feel different to allow the identify between the two controls along the bottom edge.

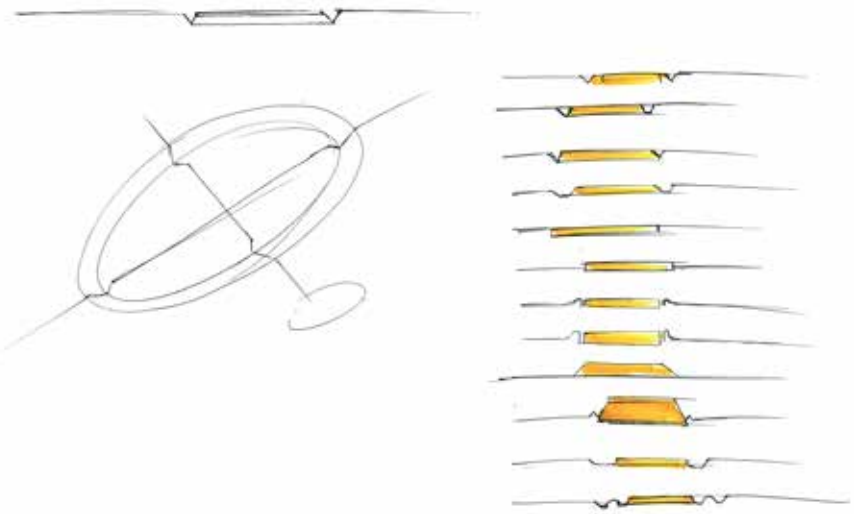
The control will take form influence from some piece of the Braun UI, using filets and smooth edges to allow the user to feel the button before finally pressing.

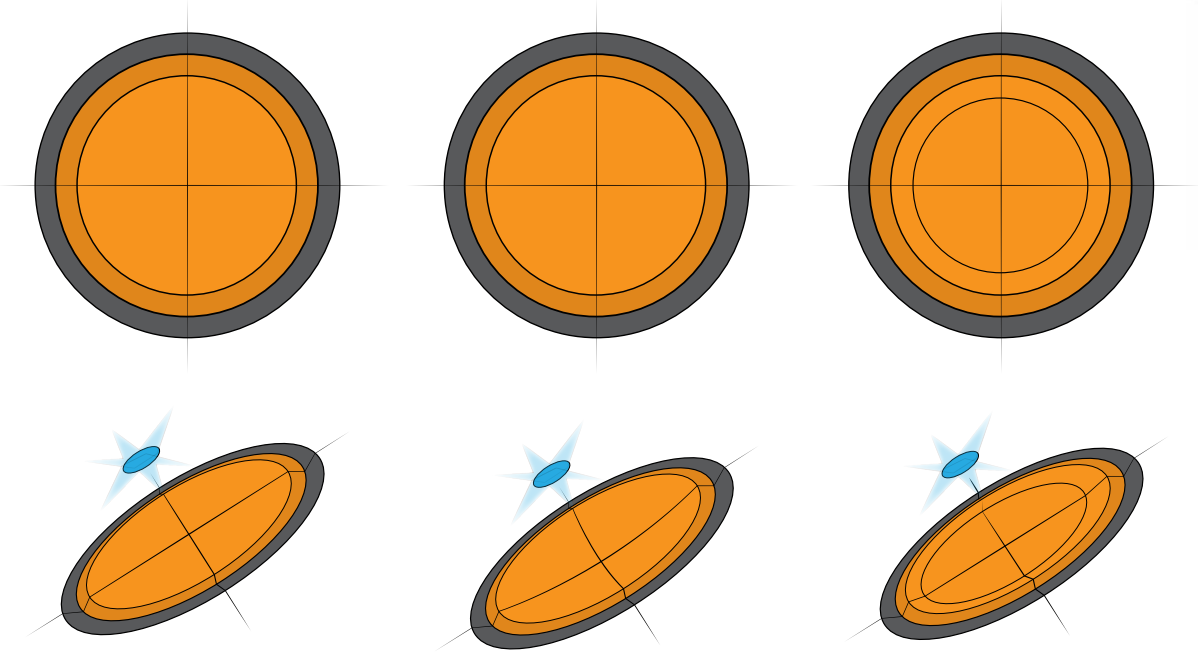
Fig. 053



Bluetooth Control

The bluetooth button will be fairly small control due to the physical space on the lower edge that a button can fit. To combat the size of the button the form has been modified form just a straight flat button. The button will feature a chamfer to allow the user to rest their fingertip within the surface of the button before pressing. As well as the button featuring a chamfer the outer edge around the button will have a mirrored chamfer. This detail will improve the usability of this small control.





Power

The product will be powered by a non removal lithium secondary battery. Other options were considered to look at how the product could be powered such as using removable primary batteries.

Non-removable lithium secondary batteries were chosen as this would allow the product to feel more high end, it should also allow the product to work by using a battery that can sustain a large charge before running low on battery.

The lithium battery ion battery will need to power a number of aspects within the design.

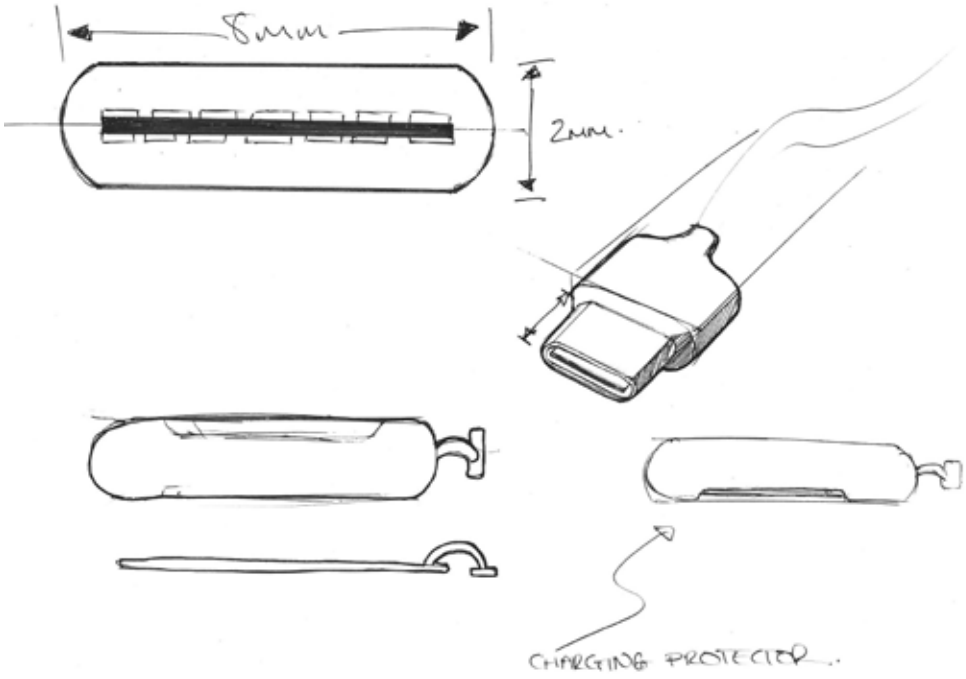
- Power Control
- Bluetooth Control
- LED's
- Small Speaker
- Low Energy Bluetooth Module
- Air Flow Pressure Sensors
- PCB

The lithium ion battery that will be used will be charged using a USB C port that will then use a USB input into a mains plug. This allows the user to remove the plug ad charge the product into anything with a USB output, such as computers and laptops. USB C port was selected due to it being the most efficient USB port type for charging in small products due to the physical size and charging speed.

USB C

The USB C port only has limited places that it can be featured within the product due to the thickness of the product being too small at certain points. The USB C port placement was developed and the position of the charging point was selected to be directly central.

One feature that was decided for the USB C was that it would have a port plug. This was decided to stop the port from attracting dirt/dust and water. The plug would be manufactured from a thermoplastic elastomer to allow the plug to be pushed in and removed using only the material as the adjustment.



Filter

During the previous section within the log when filters were being discussed the thinking was that the mask would have used a HEPA filter within the mask to filter pollution and dirt from the air before it passes through the users lungs. However, the HEPA filter was spoken about during the design freeze, discussing whether a HEPA filter would add resistance to the air flow.

Fig. 055

The Woobi Play Mask

This mask aimed at children uses a HEPA filter to avoid pollution however the HEPA in this current mask has not been designed to perform to utilise resistance training. (DesignBoom, 2017)

Fig. 056

Fig. 057

RZ Mask

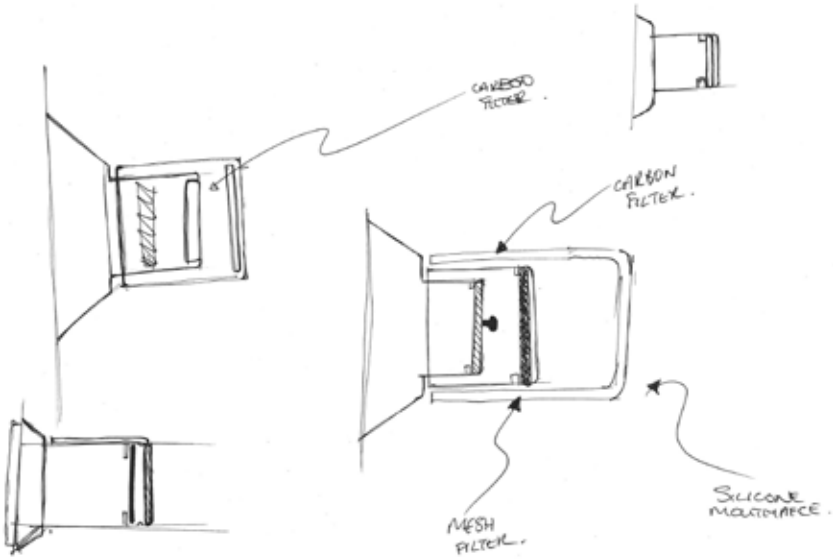
The RZ mask has three different grades of filters. The mask is aimed towards the sporting consumer group. The first filter they use in their most basic model uses a carbon element, however the filter is stated to effect air flow for the user. The second uses a HEPA filter that is mentioned to allow 40% better breathing for the user. However, the latest edition within the mask uses a high flow filter with a carbon element to allow the user maximum breath ability whilst filtering the air. (RZ, 2017)

High Flow Carbon Filter

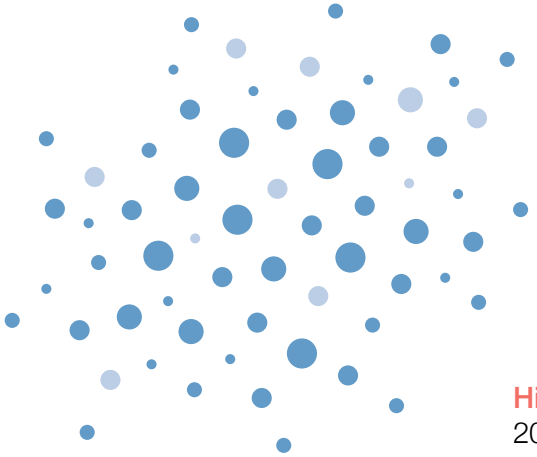
A high air flow carbon filter has been selected to be featured within the finalised design. This particular filter has been selected after looking into breathing products that use air filters.

Most filters like the Woobi Play Mask use a HEPA filter, however the design that uses this type of filter has no need to look into the air flow, so a HEPA filter would be suitable. The RZ mask on the previous page uses a high flow carbon filter. This particular filter has been designed to not influence the air flow for the user, making it the most suitable option for the finalised breathing trainer.

After selecting the carbon filter the next thought was to consider how the filter can be implemented into the design and to also provide a method for the user to remove and replace the filter after a period of time.



Low Pollution Levels
30-40 hours of continuous use

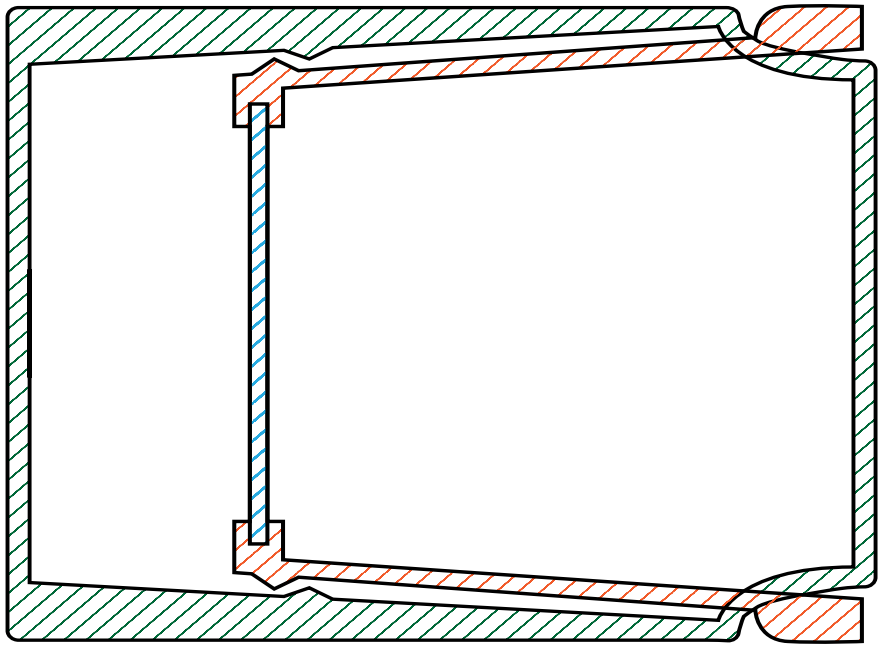


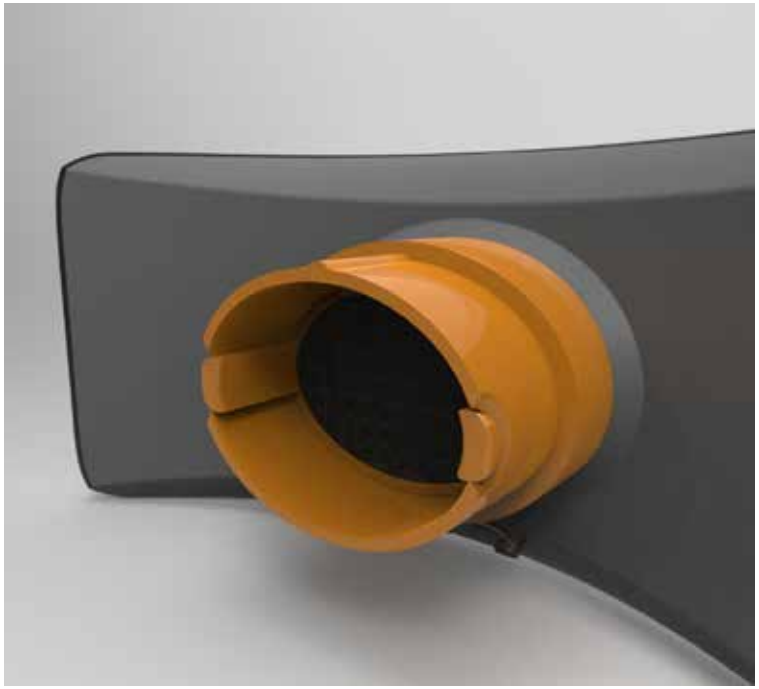
High Pollution Levels
20 - 30 hours of continuous use

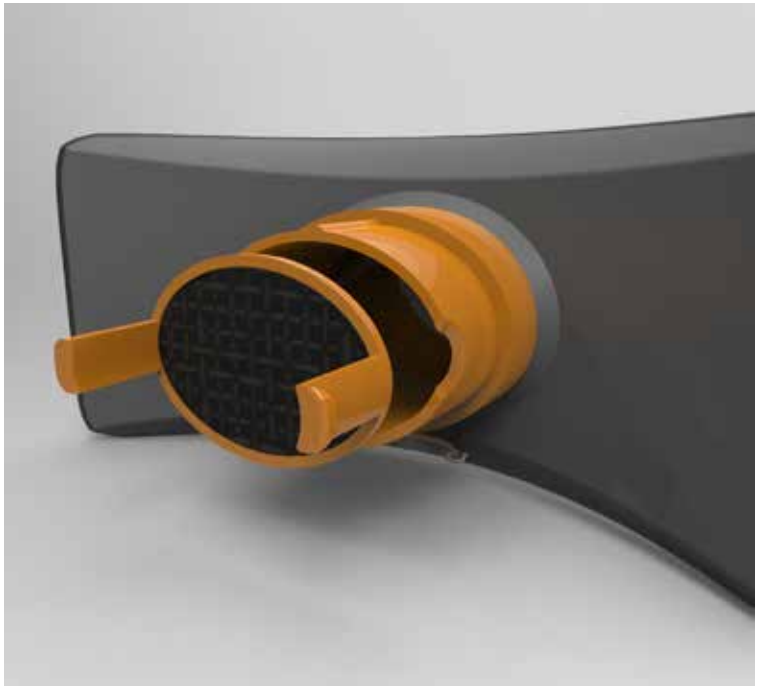
Carbon Filter Design

The carbon element filter needs to be secure when the user is using the product and when the product is being transported however when the user needs to change the filter this should still be easy for the user. This developed concept for the filter uses a draft and the flex within a unsupported polypropylene mold. To remove the filter the user would simply push in the side push points and pull freeing the filter from the product. The same interaction would be done to put in a new filter for the product.

The filter is actually three separate components that fix together. The front piece is used with an oval shaped ring that clamp together when pushed together. When they push together they trap the high flow carbon filter.





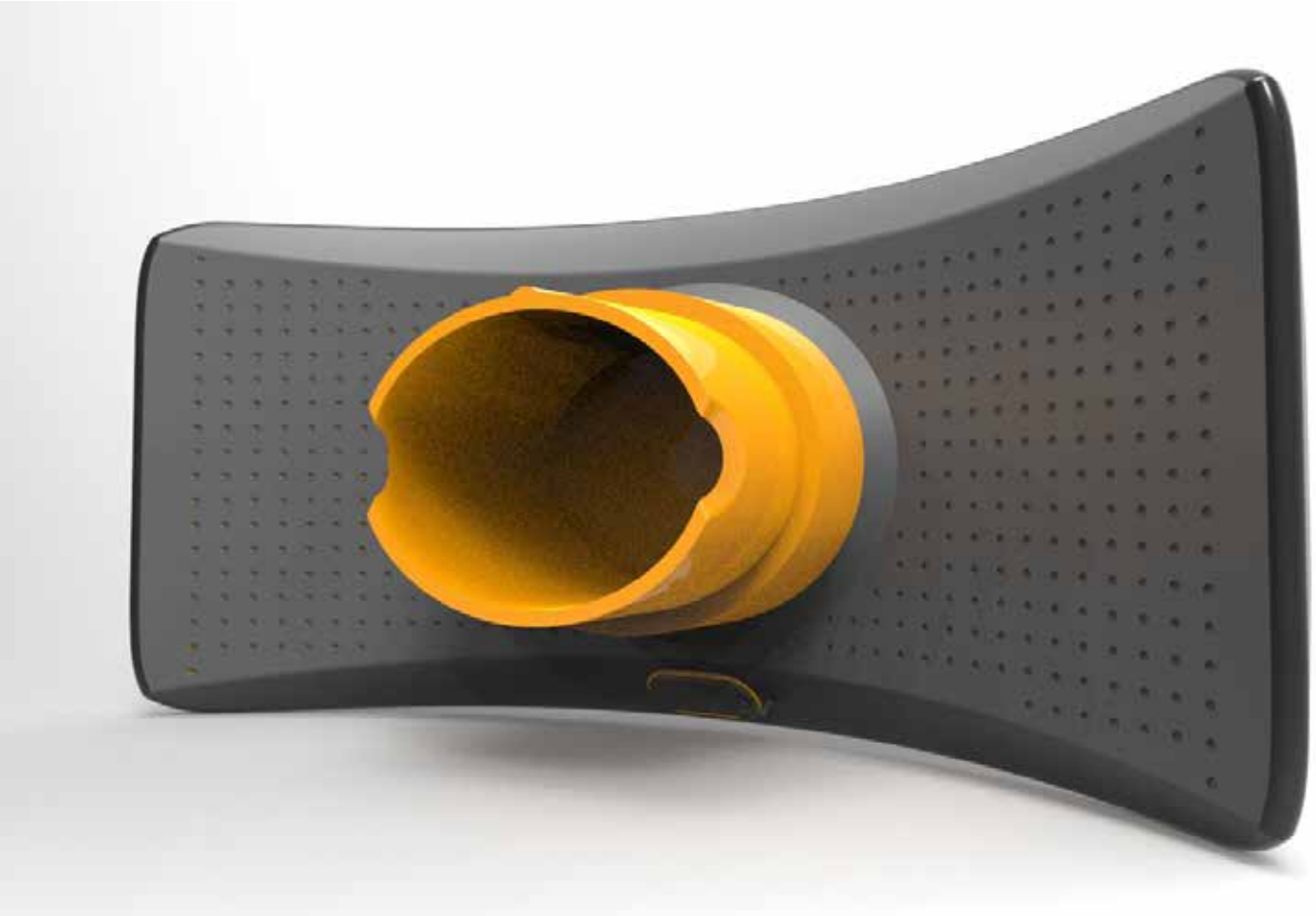


Back Panel Detail

The back panel has no controls on as this location has been identified as to where the user will be holding the product when not in use. This blank space on the design has been identified as a possible area for some texture to be applied. The relationship between users and their products is enhanced when the sense of touch is considered. A section in the design which the user will feel in their hands, although not performing any duties, subconsciously this texture will allow to receive some tactile feedback from the product.

Relationship between the sense of touch and products

According to Japanese designer, Kenya Hara, heightening the senses and blending them through design we can begin to restore users to a more direct experience of the world which Hara stated has been lost in modern technology. This is why the product will feature a surface texture on the back of the product. (van Hout, M. 2009)



The circle surface texture was decided on as it gives the product a uniformed aesthetic. The circular dots also relate to the expiratory holes on the front of the product.

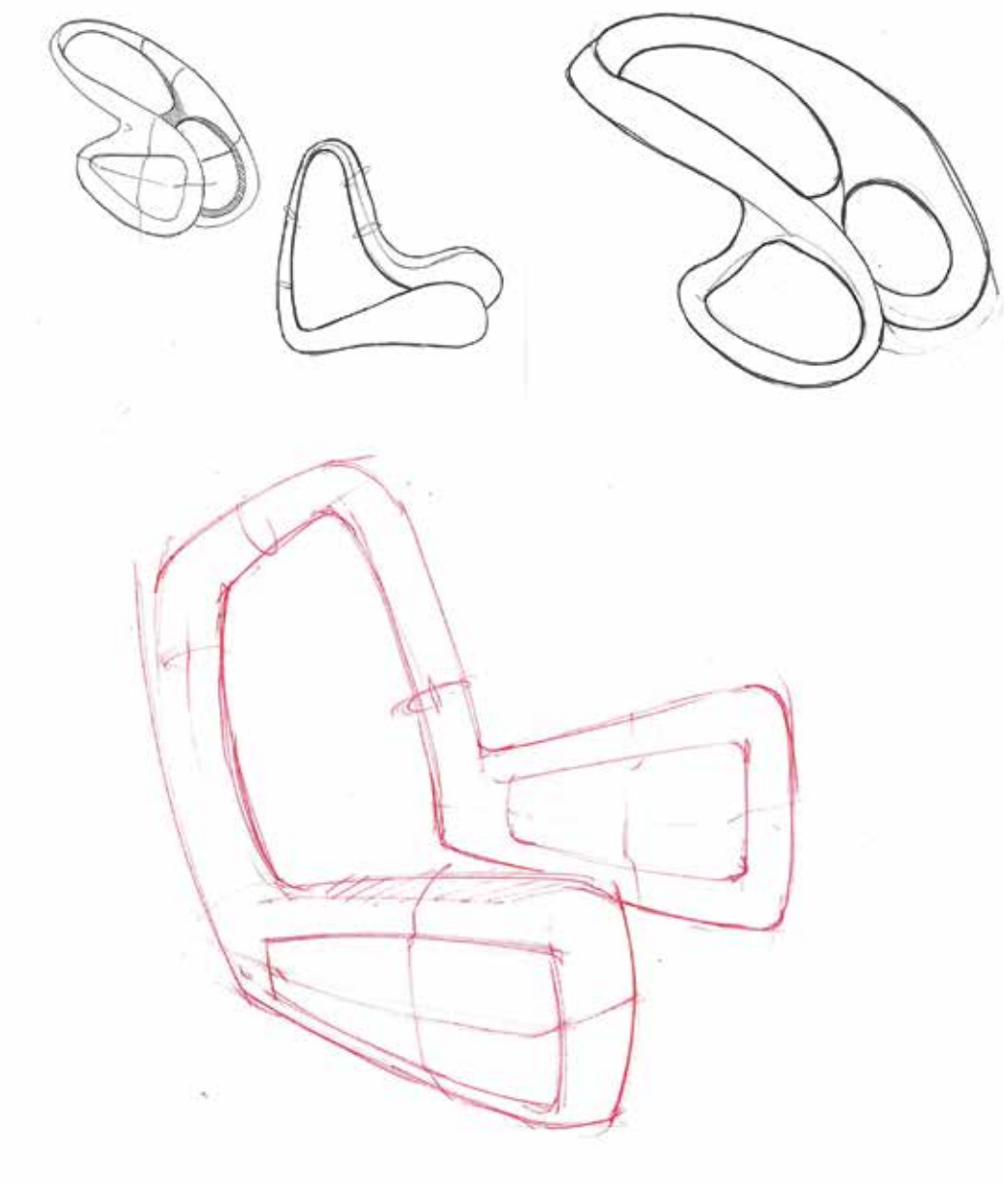
Nose Clip

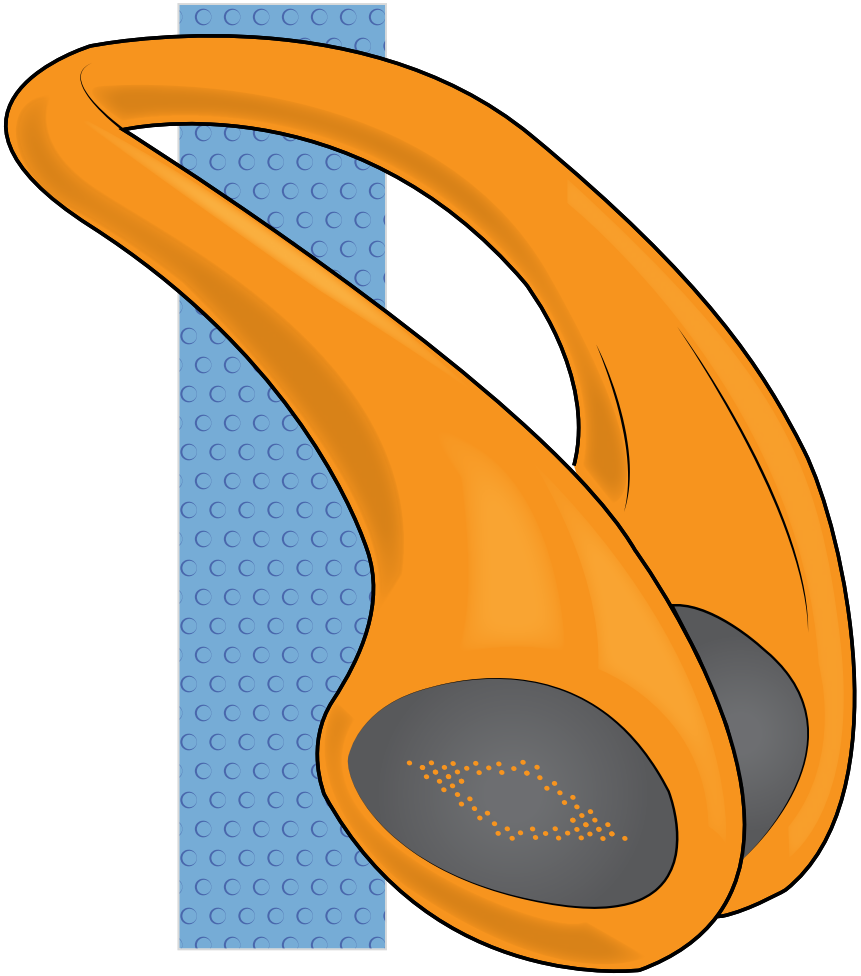
A nose clip has been looked into to accompany the product. Due to the product only covering the mouth the nose is still exposed to pull air through and into the lungs. Although when exercising using RMT the user is not meant to use their nose this can be hard to do, especially for novice users performing RMT. To combat this a nose clip will be designed for users to use when they are first starting out on a RMT programe to help them understand what it feels like to train using only air taking in through the mouth.

The mouth is used rather than the nose due to the volume of air that can be inhaled through the mouth. This allows the RMT to improve muscle strength and endurance at a quicker rate. The mouthpiece will be made from a nylon featuring a silicone insert that. The nylon will flex over the users nose to limit the air flow available through the nose.

Mouth breathing

Mouth breathing when exercising improves a number of aspects during Respiratory Muscle Training. The first aspect mouth breathing is that it allows users to move more air in and out of the respiratory system whilst exercising than using the nasal passages. Mouth breathing also prepares the body for action by triggering the bodies natural fight or flight response therefore increasing the users heart rate allowing more oxygen to flow around the body. (RunnersConnect, 2017)





Internal Electronic Components

Speaker

A small micro speaker will be housed within the product. The speaker will make sound when the product is turned on, paired to the users phone, and when the user wants to use sound within the training process. A small beep can be turned on within the app to tell the user when they should inhale and exhale.

Air Flow Pressure Sensor

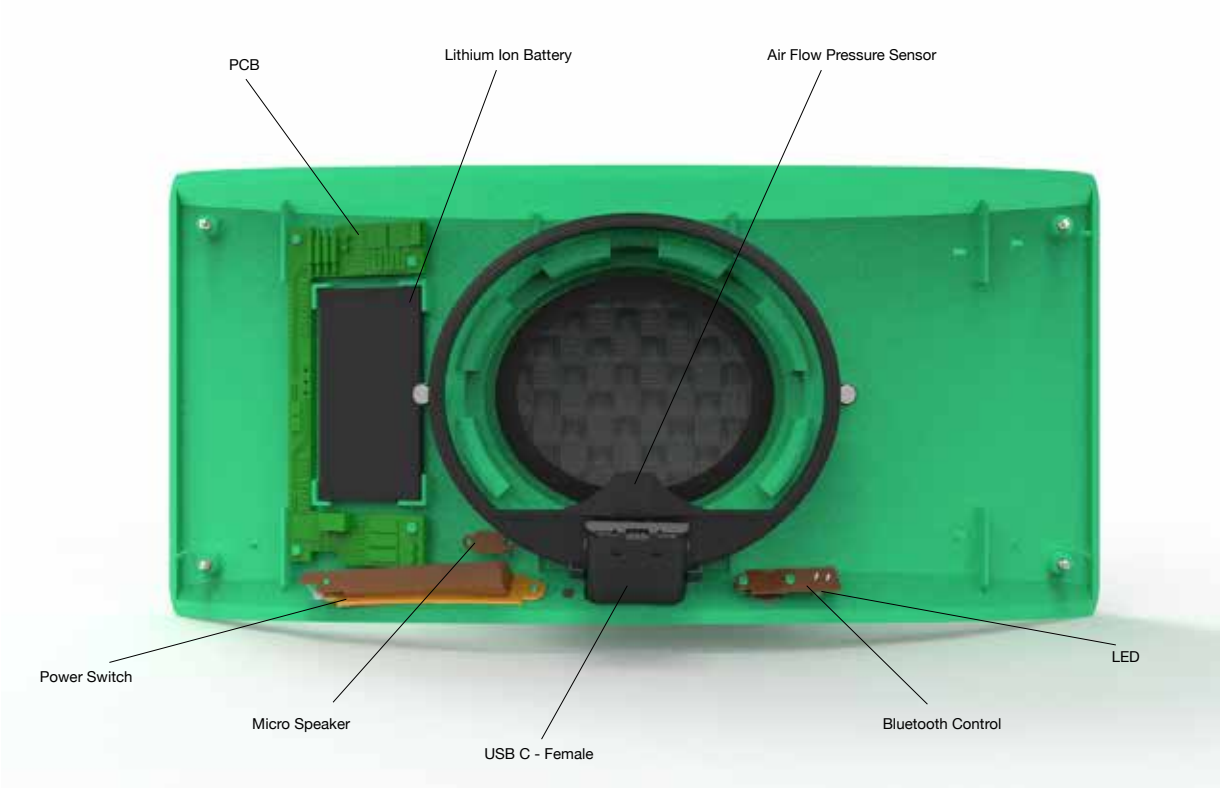
An air flow pressure sensor will be housed within an air chamber to record the users exhalation breathe so this raw data can be processed into information for the user to reflect on within their training regime.

PCB

The PCB will be housed within the back panel of the design. Connecting all of the electronic components which is then relayed to the bluetooth module so the data can be processed within the app software.

LED's

Two LED's will also be present within the design to form as visual indicators. The first LED will be used to indicate when the product is turned on with a white light. On the other side will be the bluetooth LED that will flash blue when it is looking for a pairing device and then will stay blue when it is paired with the users phone.



Breathing Internals

1- Carbon High Flow Filter

2- Rubber Air Seal

3- Air Flow Pressure Sensor

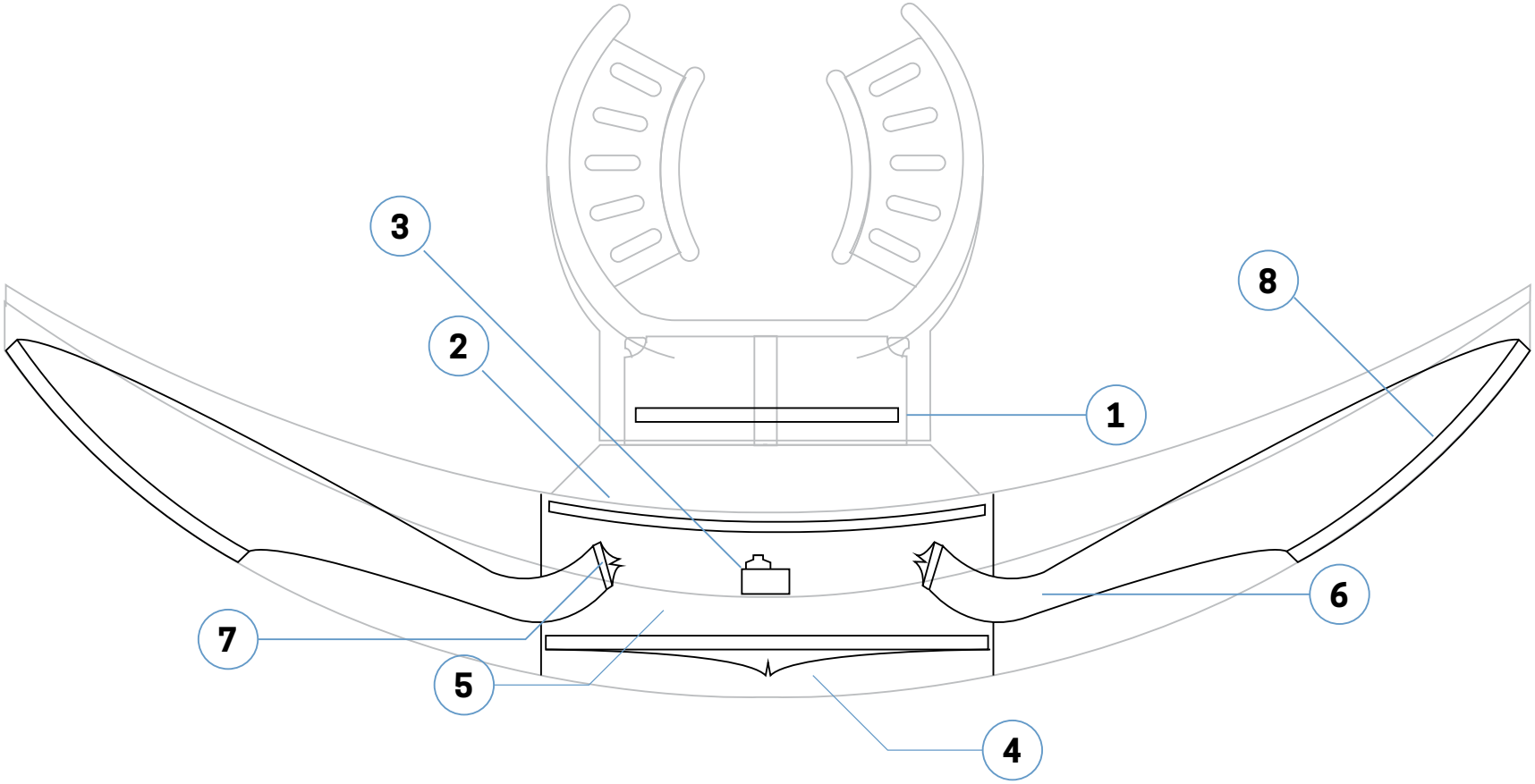
4- Expiratory Flutter Valve

5- Central Air Chamber

6- Inspiratory Air Chamber

7- Inspiratory Flutter Valve

8- Rubber Air Seal



Material Options

The materials for the product are vital so when the consumer is using the product it feels and looks like a high quality and desirable product. The main aspects to the design will be injection molded plastic parts, during this section different thermoplastics will be explored to identify the best solution for the product.

Fig. 058

Polypropylene

Polypropylene is a potential solution for the main body of the design, due to the low density, meaning when the product is sitting in somebodies mouth the weight will apply unnecessary pressure. Polypropylene also favors itself to be the main material for the product due to its good rigidity and impact balance. The other important aspect to polypropylene is the high gloss surface finish which can be achieved.

Polyamide

A Polyamide (Nylon) body could be created, due to the Polyamide being a very good thermoplastic for injection moulded parts with its high flow capabilities. Polyamide is also a great thermoplastic for rigidity and impact strength. Ensuring the product will feel like a high quality product for its user.

ABS

ABS is another potential solution for the main body. This thermoplastic is easy to mould and features good strength and stiffness. ABS also has good aesthetic qualities within the tooling and moulding process.

(Chemical Industry Online, 2017)

Material Choices

Polypropylene

Polypropylene will be the main thermoplastic used within the design mainly due to its properties lending itself to be the perfect solution for the material. The low weight that can be achieved as well as keeping its rigidity. The high gloss finish will also be used in certain areas of the design to give the product a desirable feel.

Mouthpiece

The mouthpiece used will be made from a medical grade silicone (Grade VI). This grading system means the material the mouthpiece will be moulded from would have to passed a series of tests to ensure safety within the material during a well documented and controlled process. (Albright Silicone, 2016)

Polyamide

Only a small part within the design will be a polyamide plastic. This is because the gear in which is a polyamide will be moving a lot. Polyamide is a self-lubricating material so this constant spinning will not cause any stress on the plastic part.

Colour

Performance

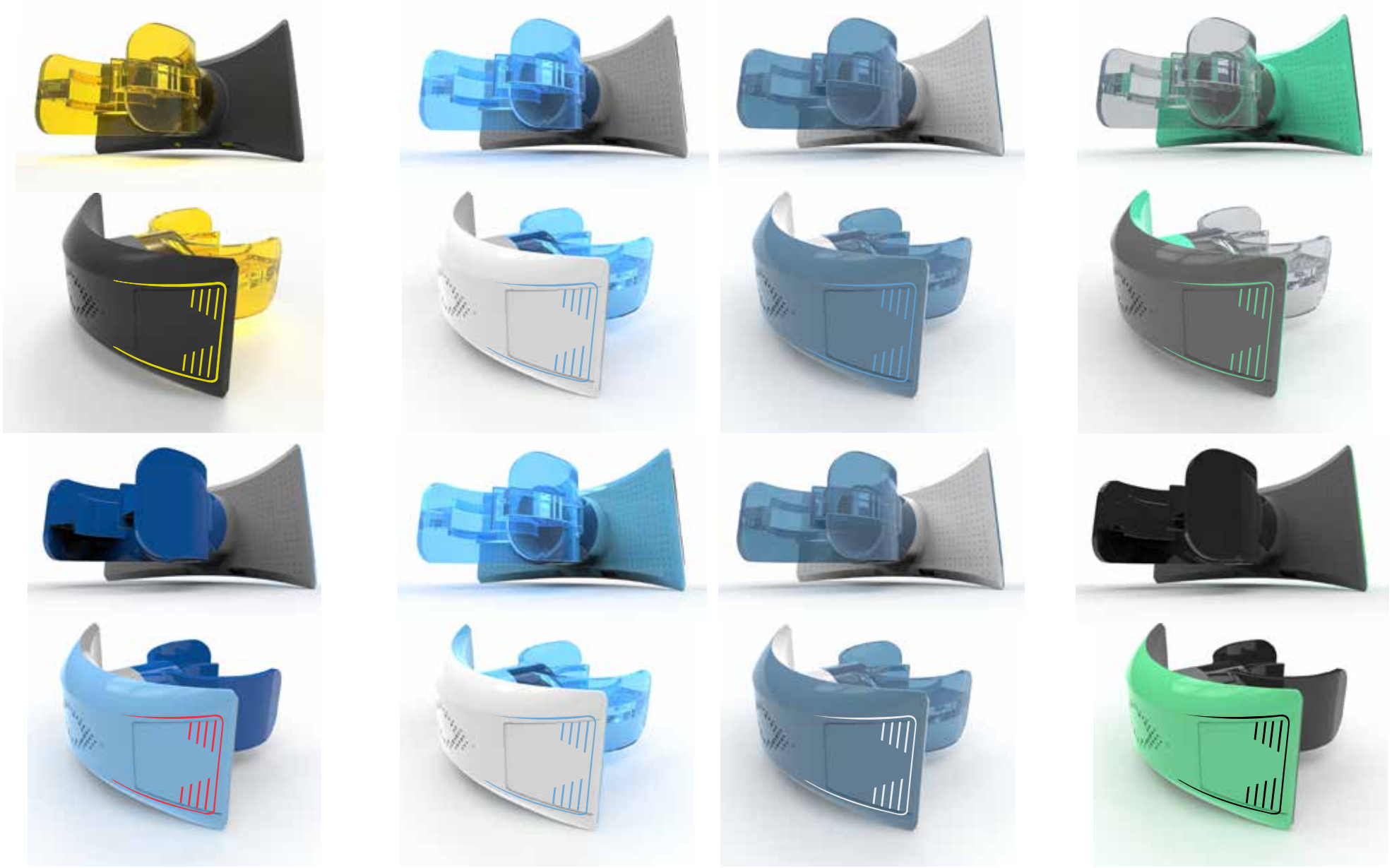
Optimise

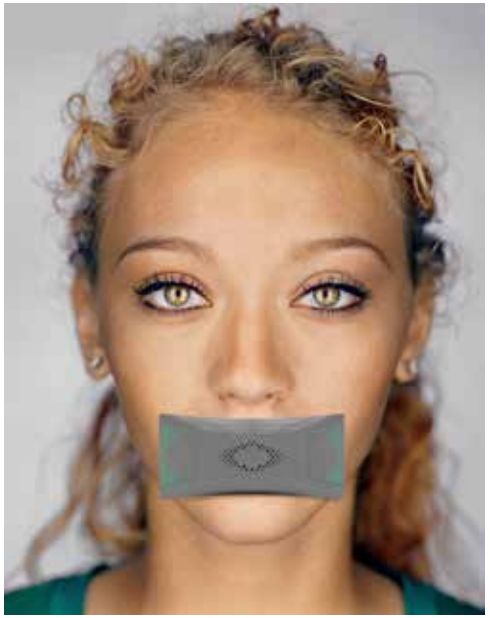
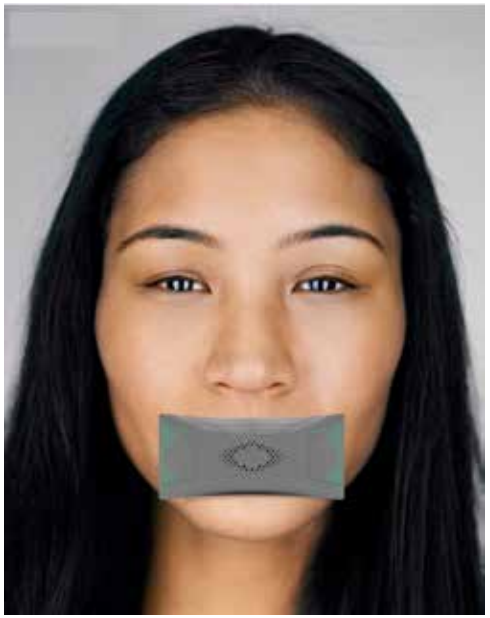
Control

Colour is a vital part of the design, with some colour changes on the next page it is present how much colour influences the overall feel to the design. To ensure the correct colour way was chosen three key words were decided to make sure the design portrayed its function; Performance, Optimise and Control.

The renderings on each page were constructed and then reflected on to observe whether they were meeting the visual language of the key words.

The black and yellow colour way on the opposing page was felt to be too aggressive and was suggesting a very masculine product. The blue and pale grey/ white's were seen as being too medical and cosmetic. The green and grey was selected to take forward to make fine adjustments to. The green and grey working together followed the visual language the product aimed to be for the target consumer.



While the colour way was being chosen the colour was checked against human faces

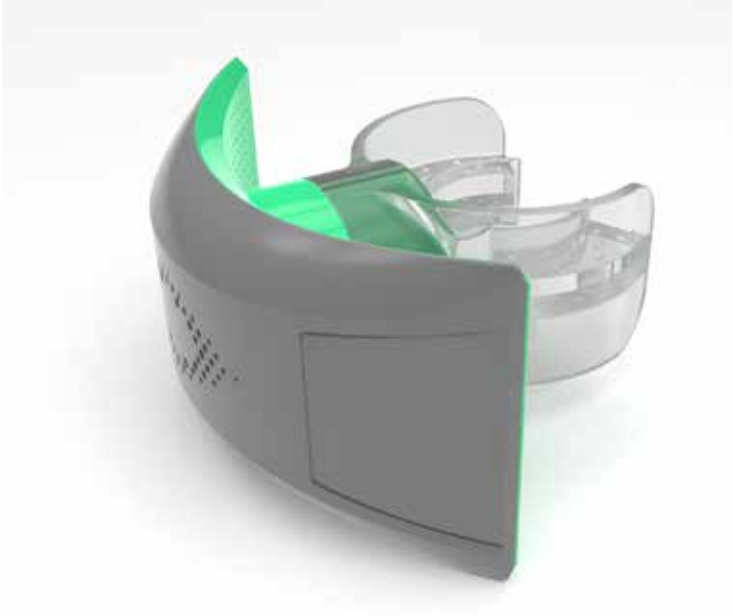
Final Colour Way

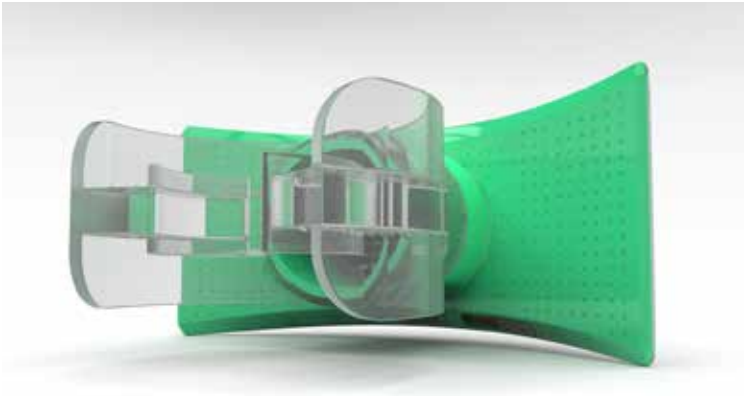
The final colour way of green and grey with an accent of orange within the on button was chosen to suit the visual language words.

The green was also chosen so it could be transfered and used within the app and branding as the products featured colour.

The green will accompany the products logo and name and become part of the branding for the product. Giving the product a unique colour will help the product establish itself within the market as recognisable brand and will potentially help spark interest around the product.

In a study it was found that 90% of snap judgments about products were based on colour alone (Ciotti, 2016). This shows the importance of getting colour right in a consumer product.

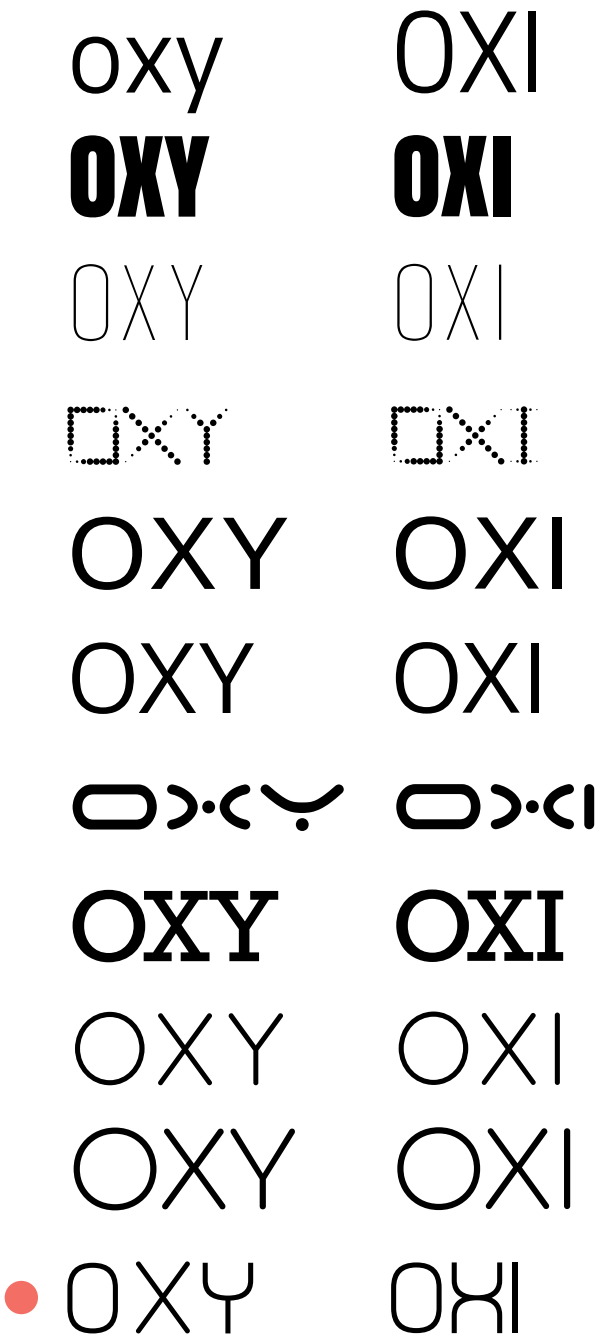




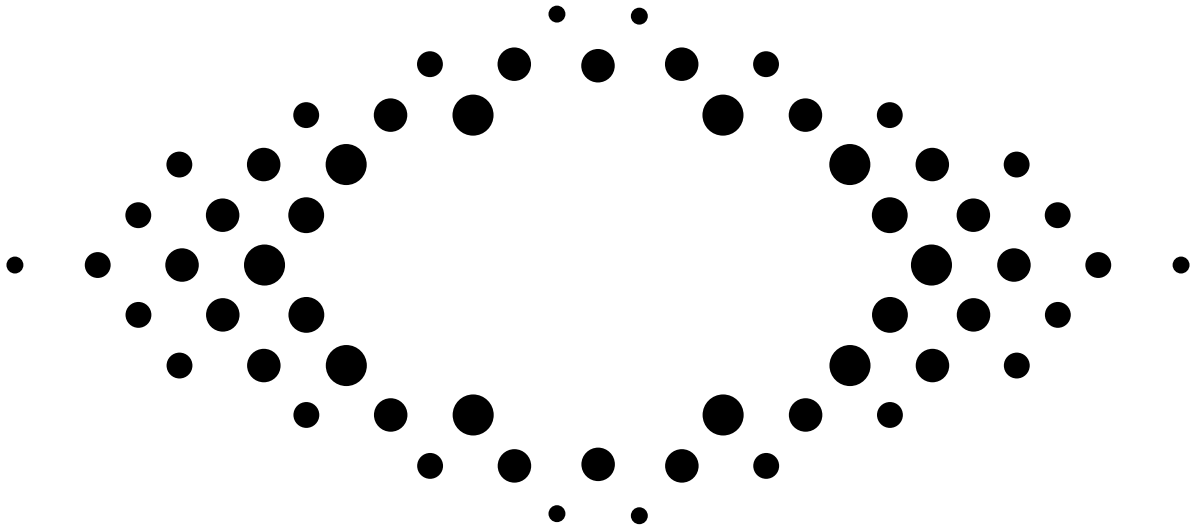
Product Name and Font

Oxy was selected as the name of the product. A number of different names were put forward such as vent, breathhub and Rspire. However, oxy was selected for a few reasons. The name, Oxy is short and easy to remember giving it a more marketable appeal. Oxy simply takes inspiration from the word oxygen, due to oxygen being the biggest factor within the product. Controlling oxygen flow is one of the products most vital functions.

The font was selected again to try and suit the house style of the product and the brand. This would have a big impact on the overall branding of the product. Branding is a very important aspect of how sports products are perceived by consumers so making sure aspects like the product name and font is correct is a vital part of the design process.



Logo



The logo was decided upon after a series of initial ideas were generated. After reflection looking at the proposed initial logo ideas for Oxy it was made apparent that the expiratory breath holes hold a lot of graphical impact. The expiratory holes were then transformed into a flat vector. Once this was created it was decided that this would become the products logo.

The expiratory holes (now logo) represents Oxy and the process of breathing using the gradual hole sizes and the form of an expanding graphic to represent the lungs filling with air.

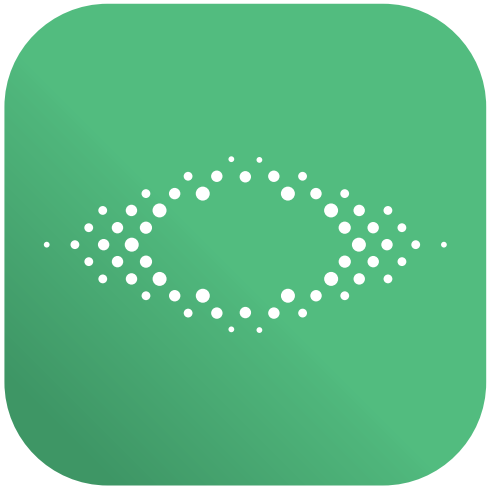
Companion App

The companion app is a direct way in which the consumer will interact with the product and the brand. To ensure the user has the best experience when using the product the app needs to be thought about to ensure the user can easily interact with the software in a simple yet resolved way. The first thing that was done to ensure the app was meeting the users need was to plan everything the app would do for it's user.

The app was then split into five key sections that form as the headers for the app.

- Dashboard
- Results
- Coaching
- Challenges
- Account

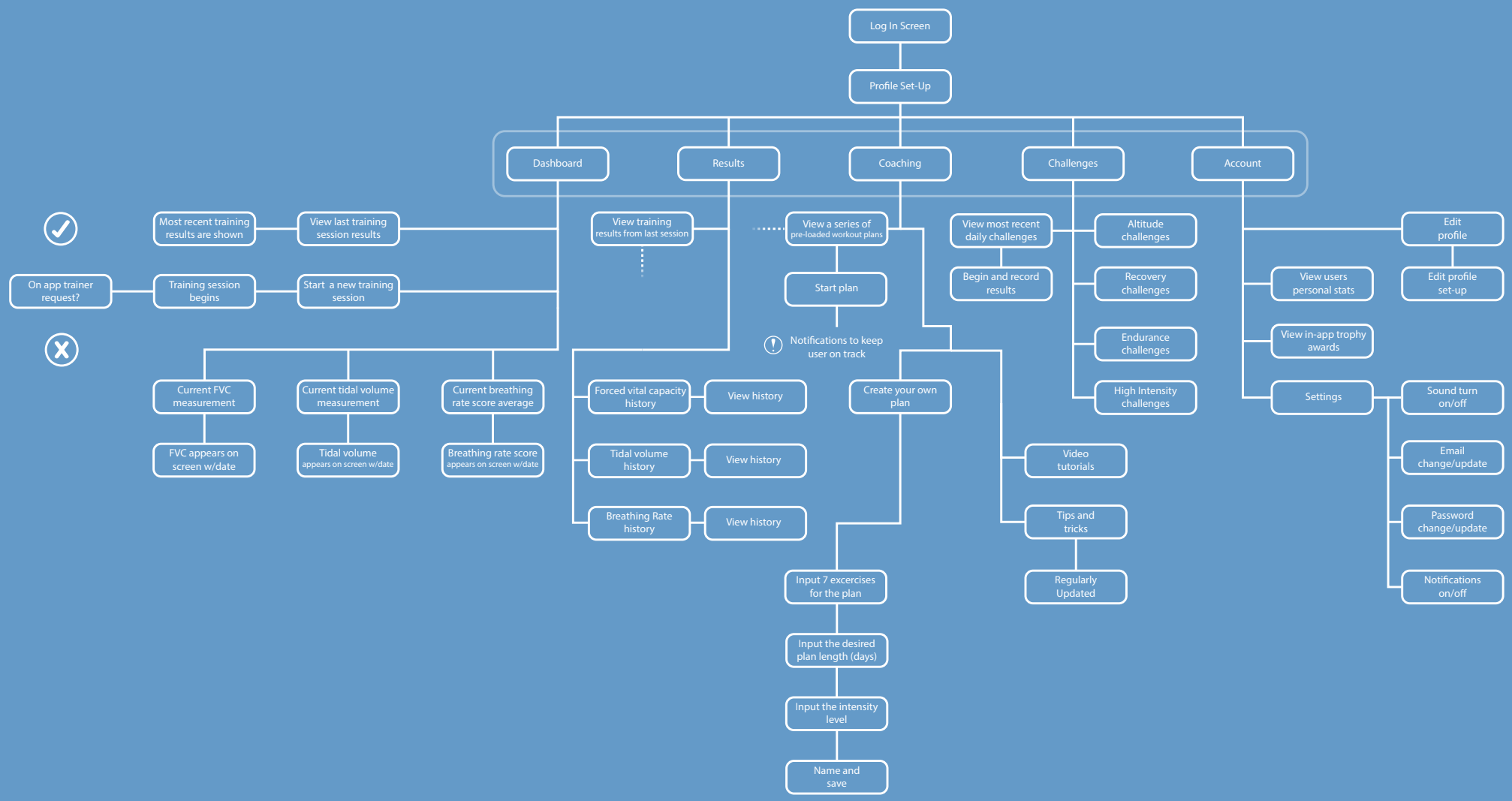
An app skeleton was then created to identify the different paths within the app so the user can easily navigate the app in a controlled way. The skeleton on the next page outlines every page and sub-page available for the user to interact with.



GET IT ON Google Play

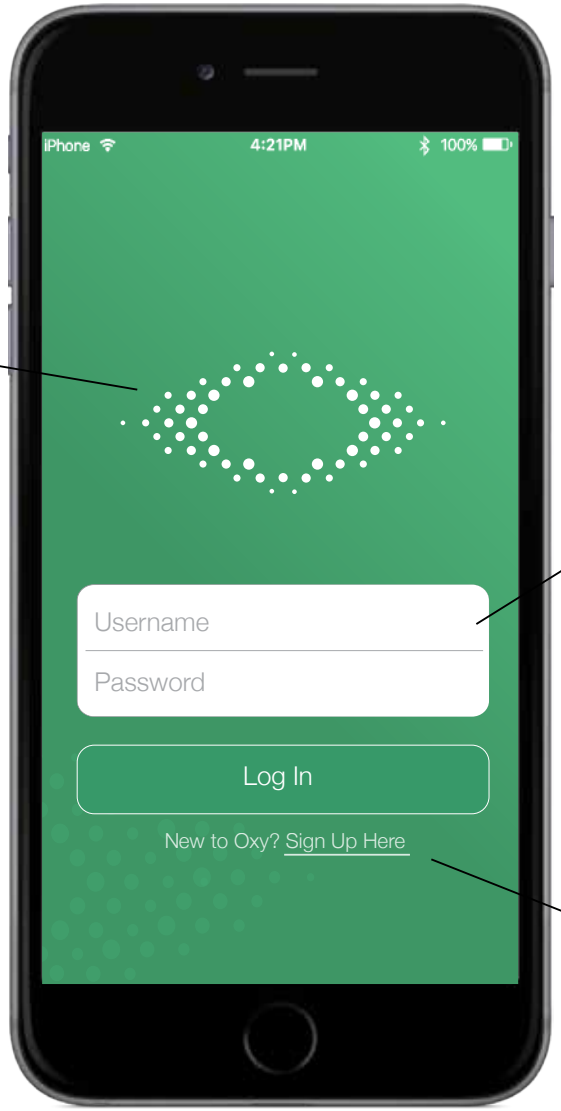
Download on the App Store

App Skeleton



Companion App - Log In

Brand logo shows as a large prominent feature during the log in screen to boost brand identity.



User inputs their personal username and password to log in to their Oxy account

New users click “sign up here” to create an account with Oxy

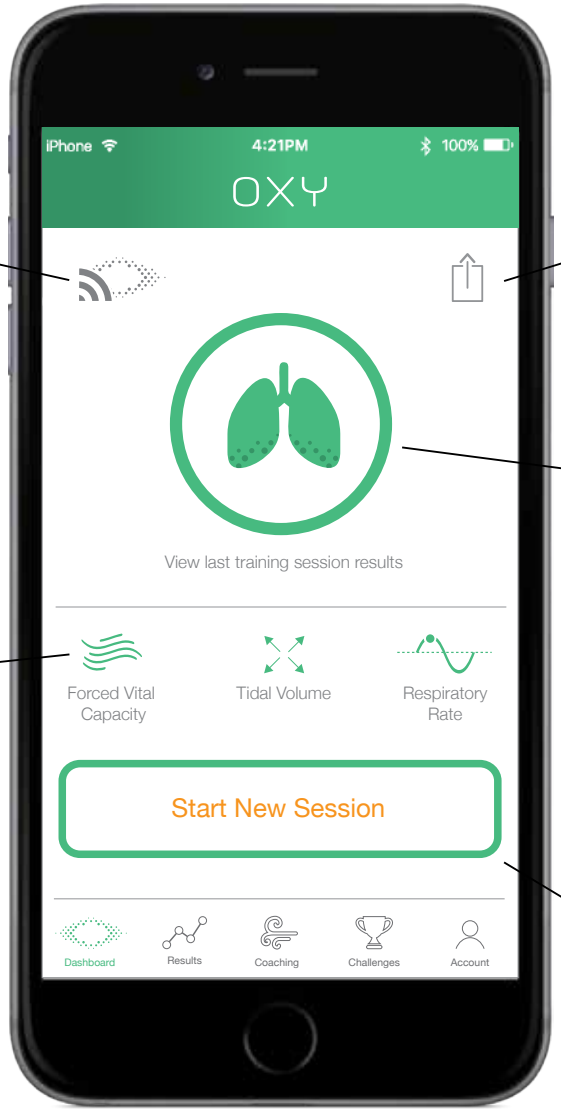
Companion App - Profile Set Up

User selects their gender, height, weight and age. They then save their profile information so the app can use this information when offering coaching tips for the user.

Companion App - Dashboard

Pair the app with users phone so data can be transferred between the two supporting media

Share last training session results with friends on social media



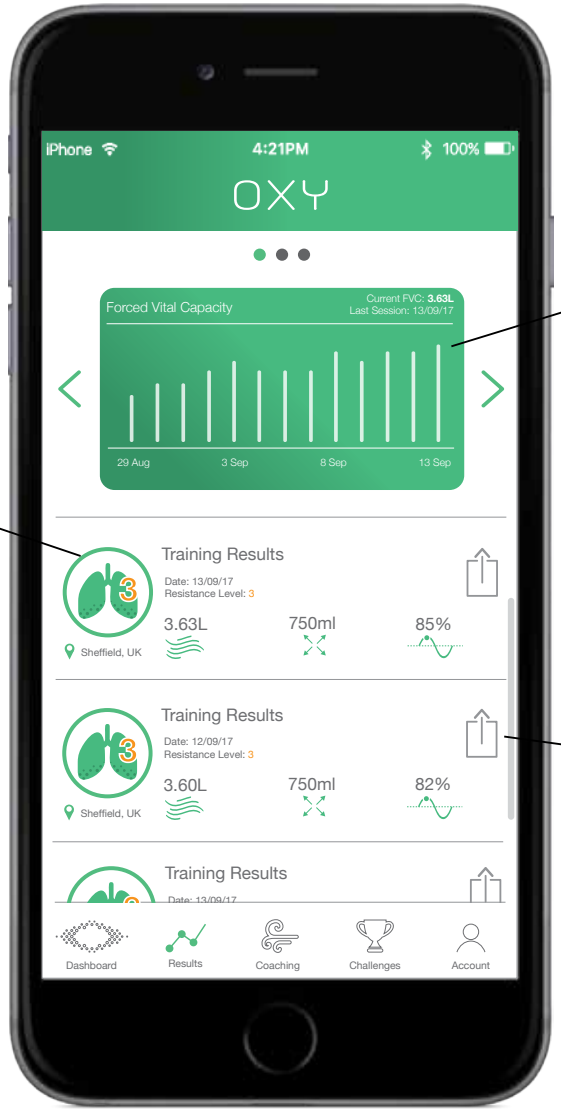
View last training session results

User can view their current lung performance, such as forced vital capacity, tidal volume and respiratory rate

Start a new training session, in-app prompt will appear asking if user wants to use in app trainer during exercises

Companion App - Results

The training results can be viewed by the user, information shown such as date, location, and resistance level



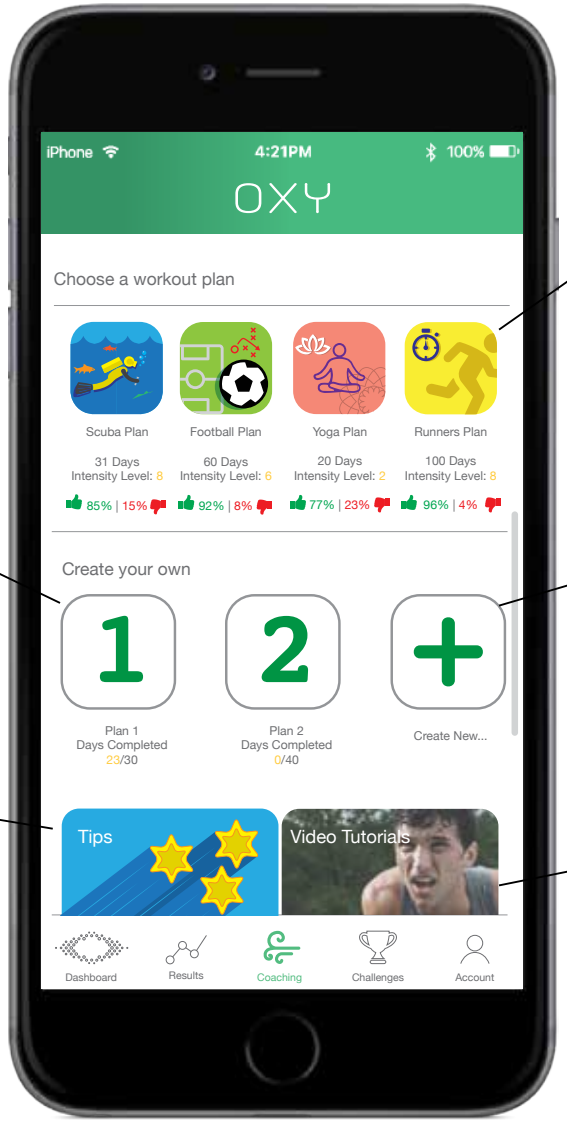
Graphs of results can be viewed so user can graphically plot and view their improvements

Share last training session results with friends on social media

Companion App - Coaching

Create your own work out plans can be viewed and begun from this screen.

Tips and tricks about respiratory muscle training and how users can use this in sporting situations



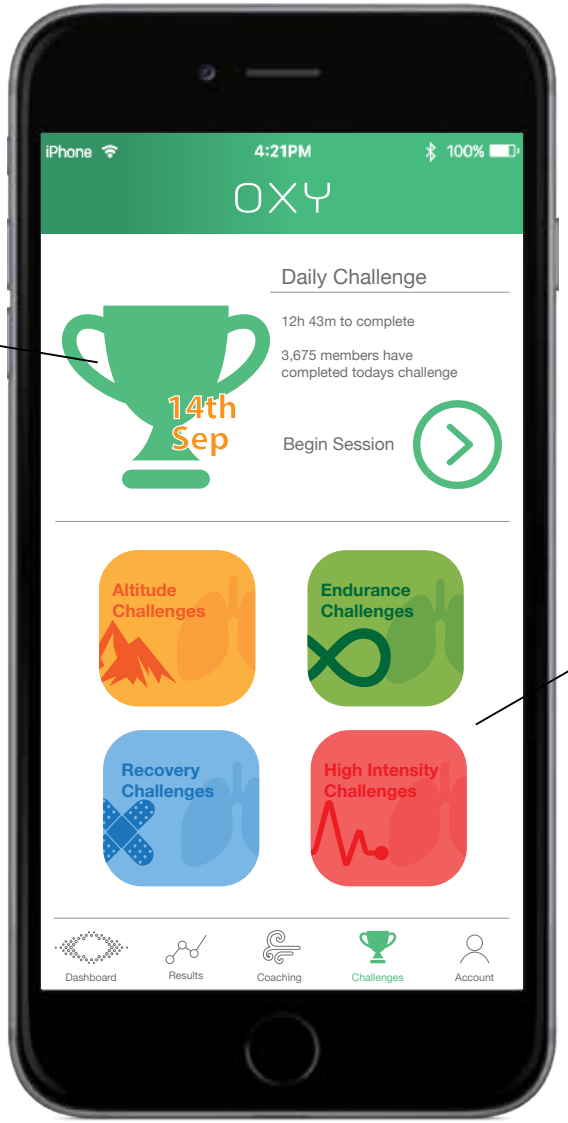
Pre-loaded workout plans are placed into the app with users taking part and rating them. They are pesonalised to different aerobic and anaerobic exercises for different sporting requirements.

User can create their own workout plan where they input details to create a tailored breathing plan.

Video tutorials with individuals teaching users about breathing exercises

Companion App - Challenges

Daily challenges will be updated every 24 hours. The session will ask users to complete a series of breathing exercises one set at the start of the day and one at the end of the day.

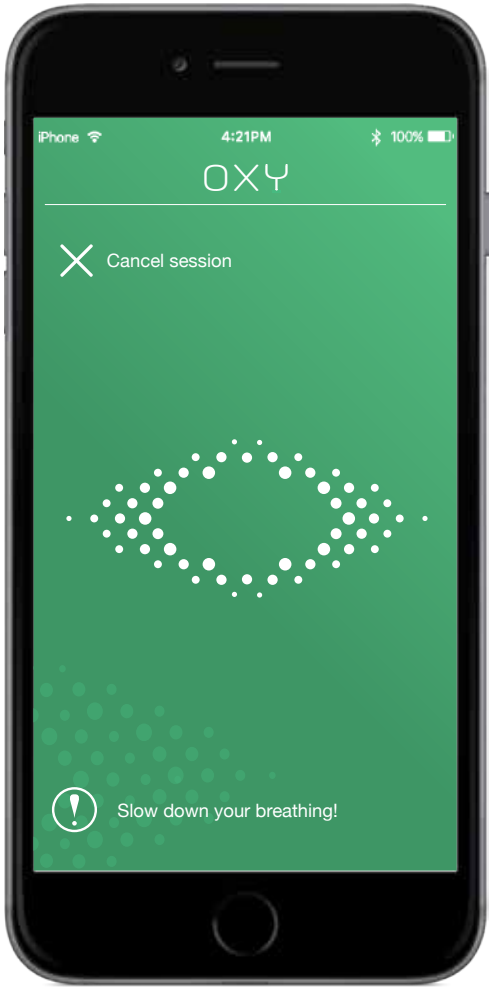


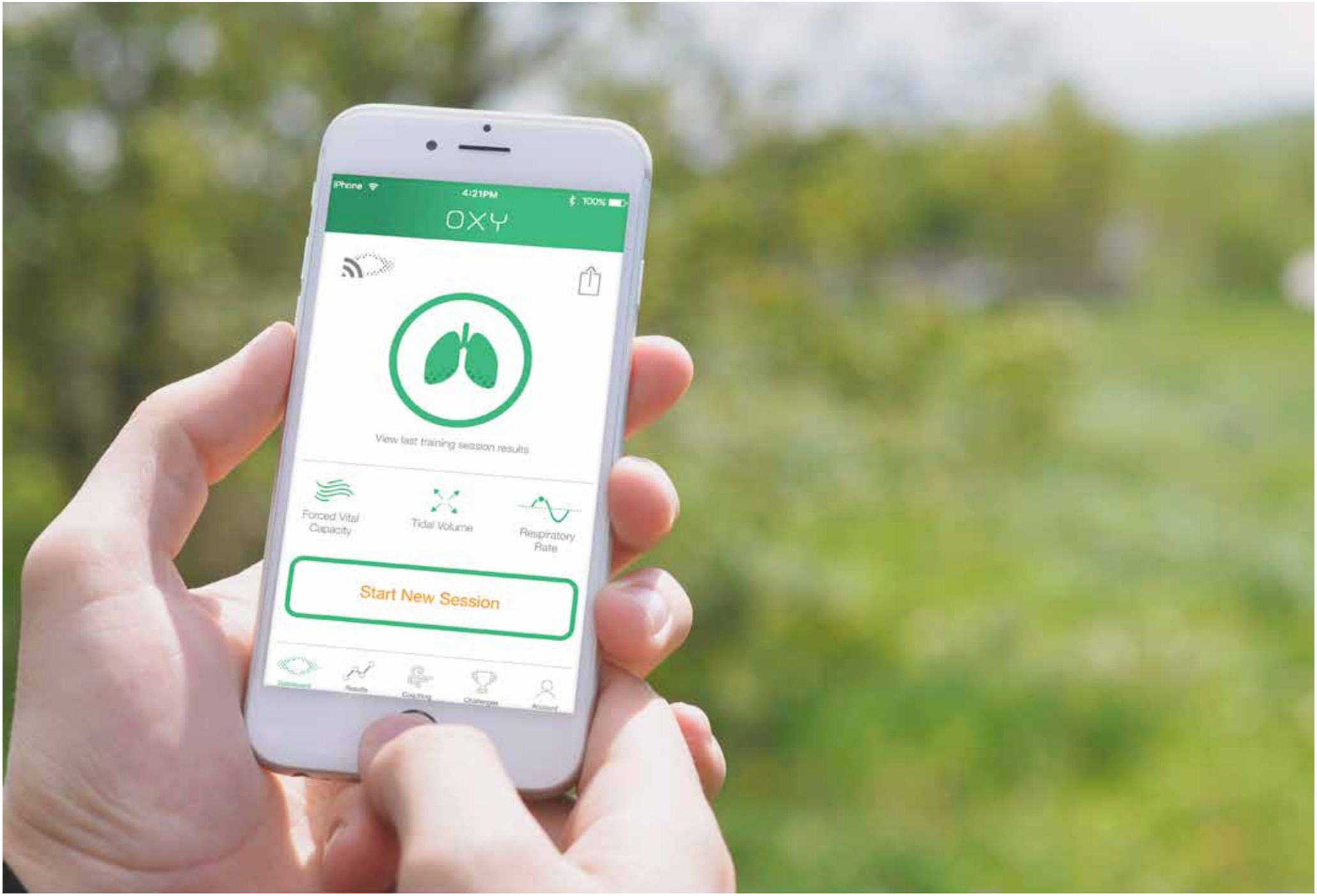
Challenges within this menu based on what the user is looking to improve. For example, if the user wants to improve lung endurance they will take part in lung endurance breathing exercises.

Companion App - In App Trainer

The in-app trainer works by using visual cue's. The app trainer will use information passed from the air flow sensor inside of Oxy, this will relay information as to when the user should exhale and inhale to improve breathing rate. The in-app trainer will use the logo to help the users with this. As the users exhales the logo will grow and the screen will be grey. Once the user starts to inhale the screen will turn green and the logo will begin to shrink.

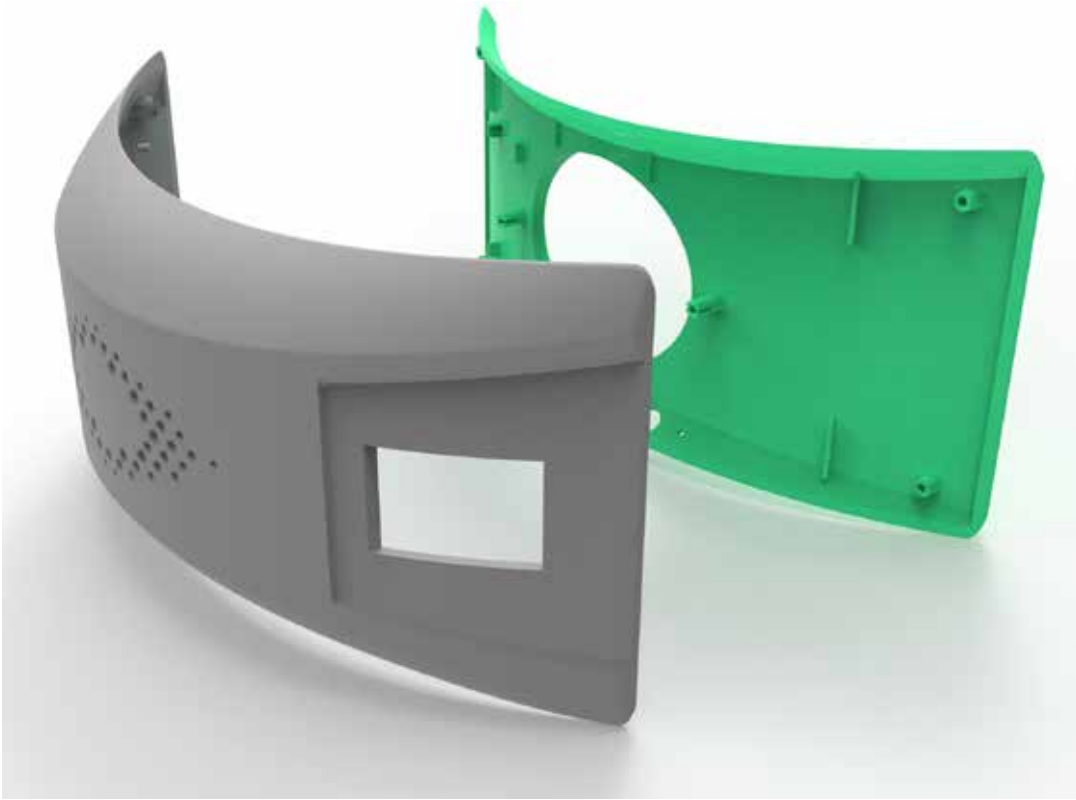
The in-app trainer also features a small notification bar at the bottom of the screen to give the user advice whilst breathing.



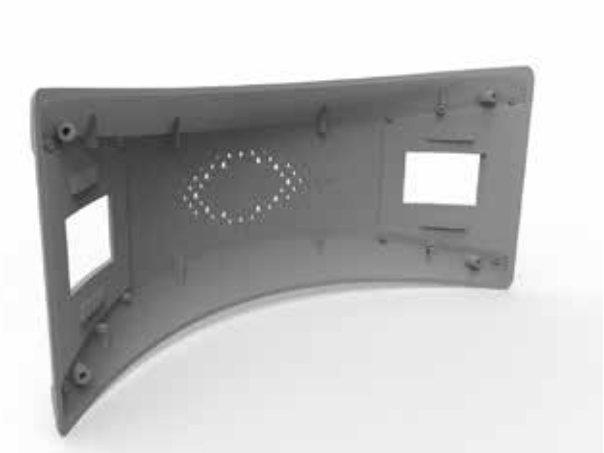

iPhone
4:21PM
100%
OXY
View last training session results
Forced Vital Capacity
Tidal Volume
Respiratory Rate
Start New Session

Manufacture - Product Body

The main two body panels of the product will be manufactured from polypropylene. The polypropylene will be injection molded into a form with a wall thickness of 1.5mm. The two halves fix together using a hook and groove tightened with four screws in each corner. Both parts house components, the front face mostly houses the breathing components whereas the back face houses most of the electronic components. The parts will be moulded with a tolerance of ±0.2mm.

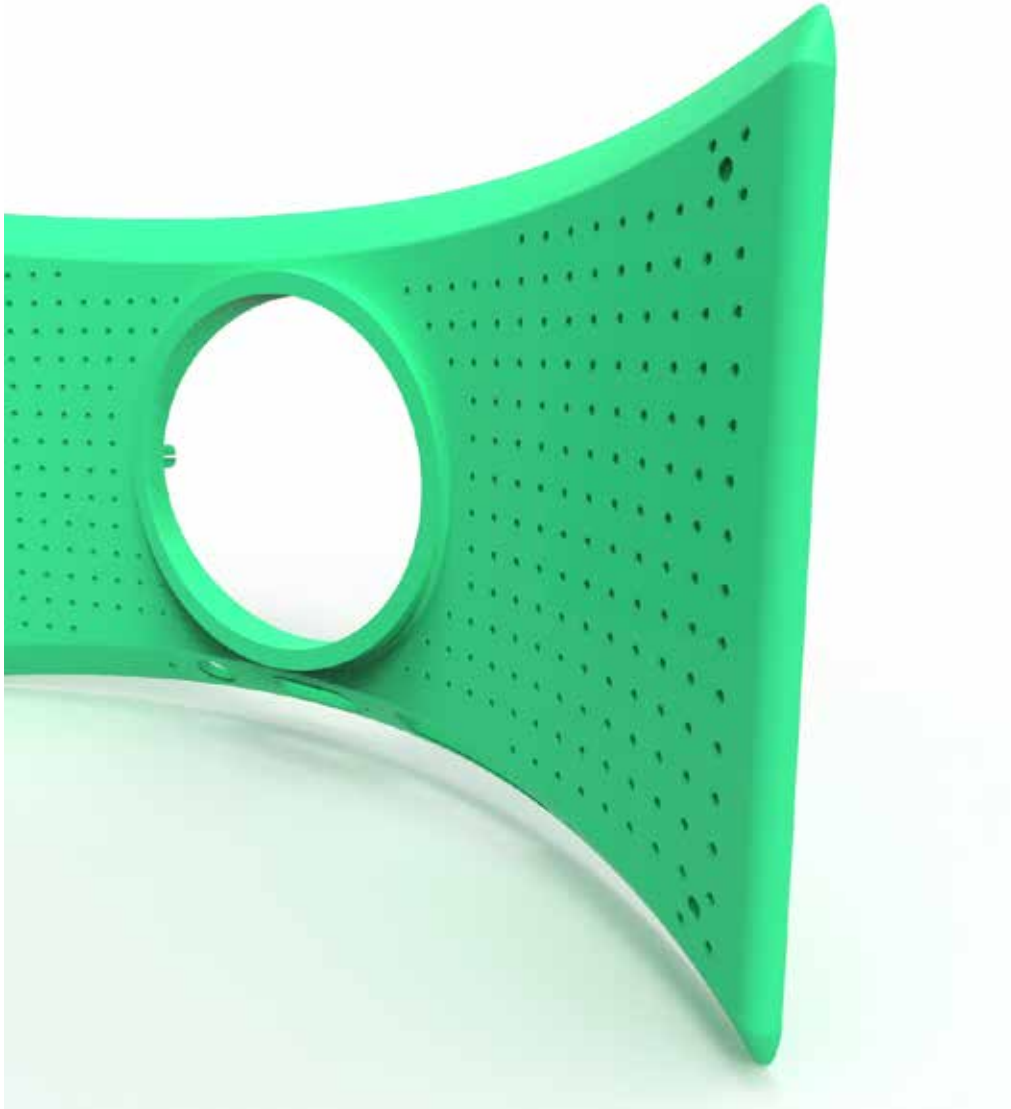


The back face houses most electronic components. It also has three cut outs for the power, bluetooth and USB C port. The part also has some smaller ribs within the part to strengthen the structure. The part will also have SP1-A2 finish on the cosmetic side, which refers to a gloss grade 2, diamond buff. All ribs and bosses will be in within the line of draw.



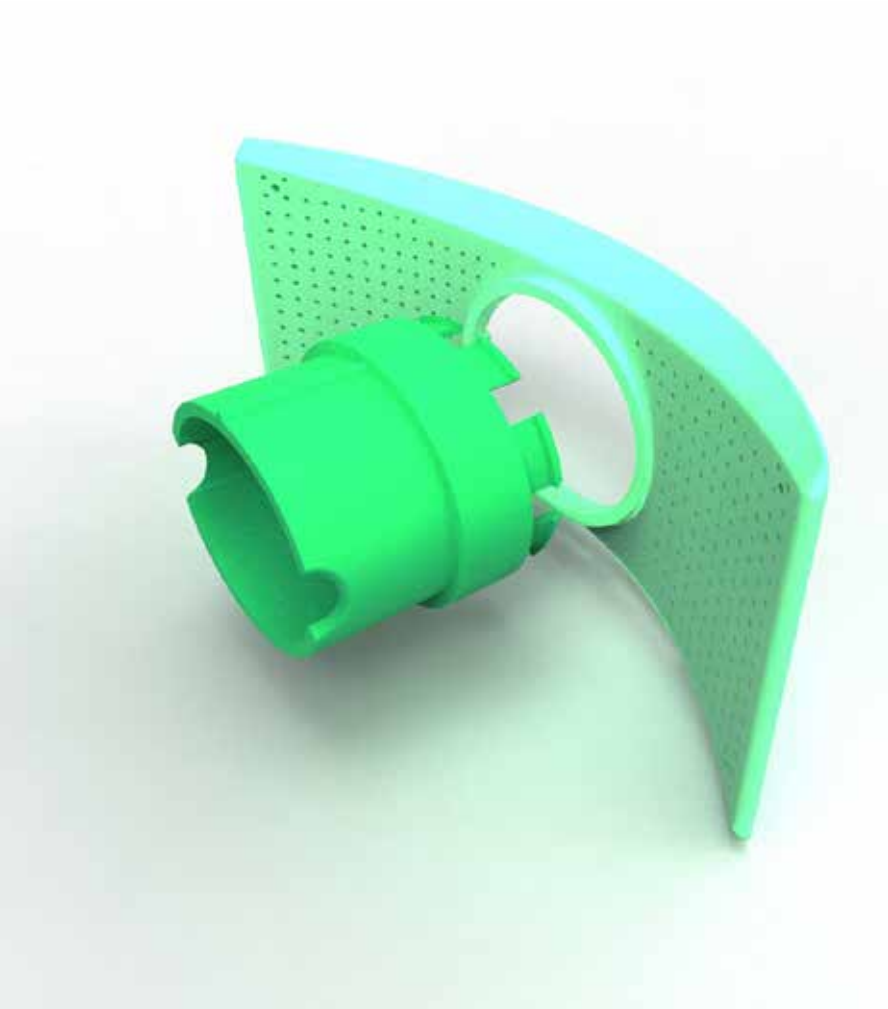
The front face houses all the electronic components and also has the molded ridges to give the user physical feedback when adjusting the resistance sliders. The part has smaller ribs and bosses that house the screws to fix the air chambers and two bodies together. The part will have a PM-T2 finish that refers to polypropylene plastic, slight sparked finish.

Manufacture - Surface Texture

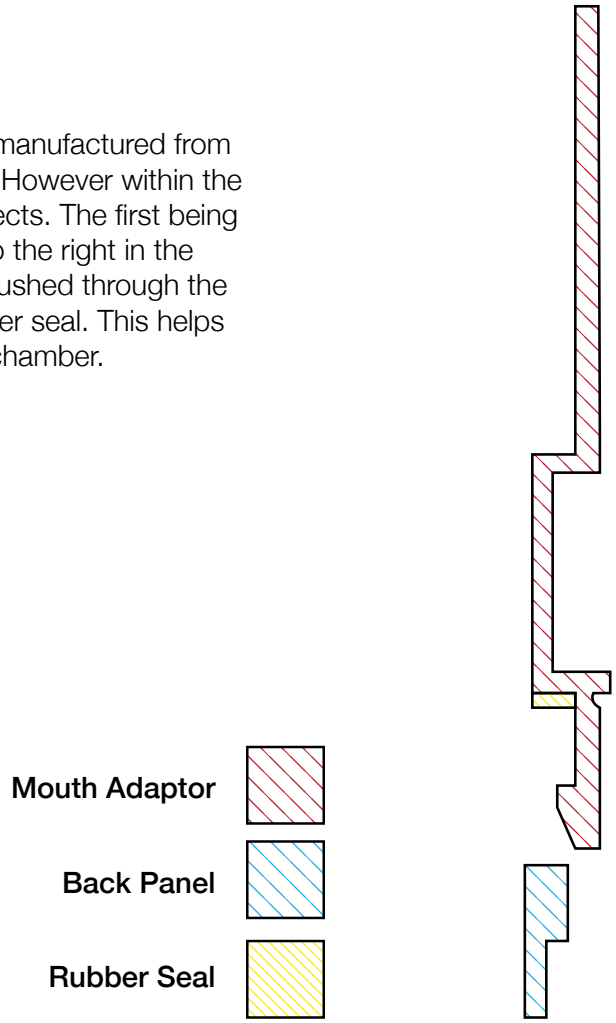


The back panel features a surface texture that will be embossed into the surface of the tool. The tool would have a hardened surface to repeat this small detail, if the product was to be mass manufactured. The surface texture will also require a degree angle of 2. This allows the part to be easily released out of the mould. (Kerkstra, R. 2014)

Manufacture - Mouthpiece Adaptor

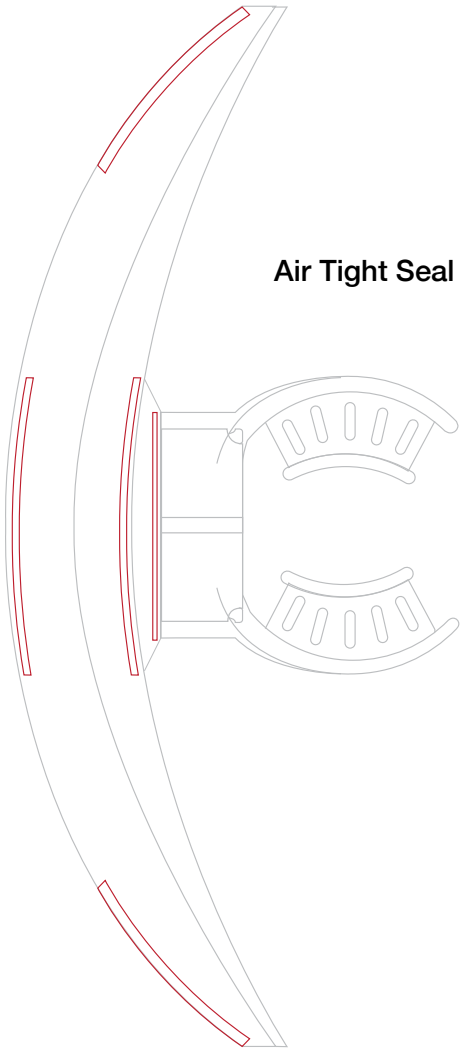


The mouthpiece adapter will be manufactured from a polypropylene injection mould. However within the mould will be two important aspects. The first being the push snap fitting explained to the right in the diagram. As the mouthpiece is pushed through the back panel it will squeeze a rubber seal. This helps create an air tight seal in the air chamber.



Manufacture - Air Tight Seals

Within the design there is a number of areas that need to feature an air tight seal. An air tight seal apart from within the snap fixing is featured within a number of positions, however the seal is fixed in with small screws. The screws are tightened to help form an air tight seal between the inner air chambers and the air openings. The image below shows how the white internal part is used to clamp the air tight seal into place with two screws.



Air Tight Seal Placements

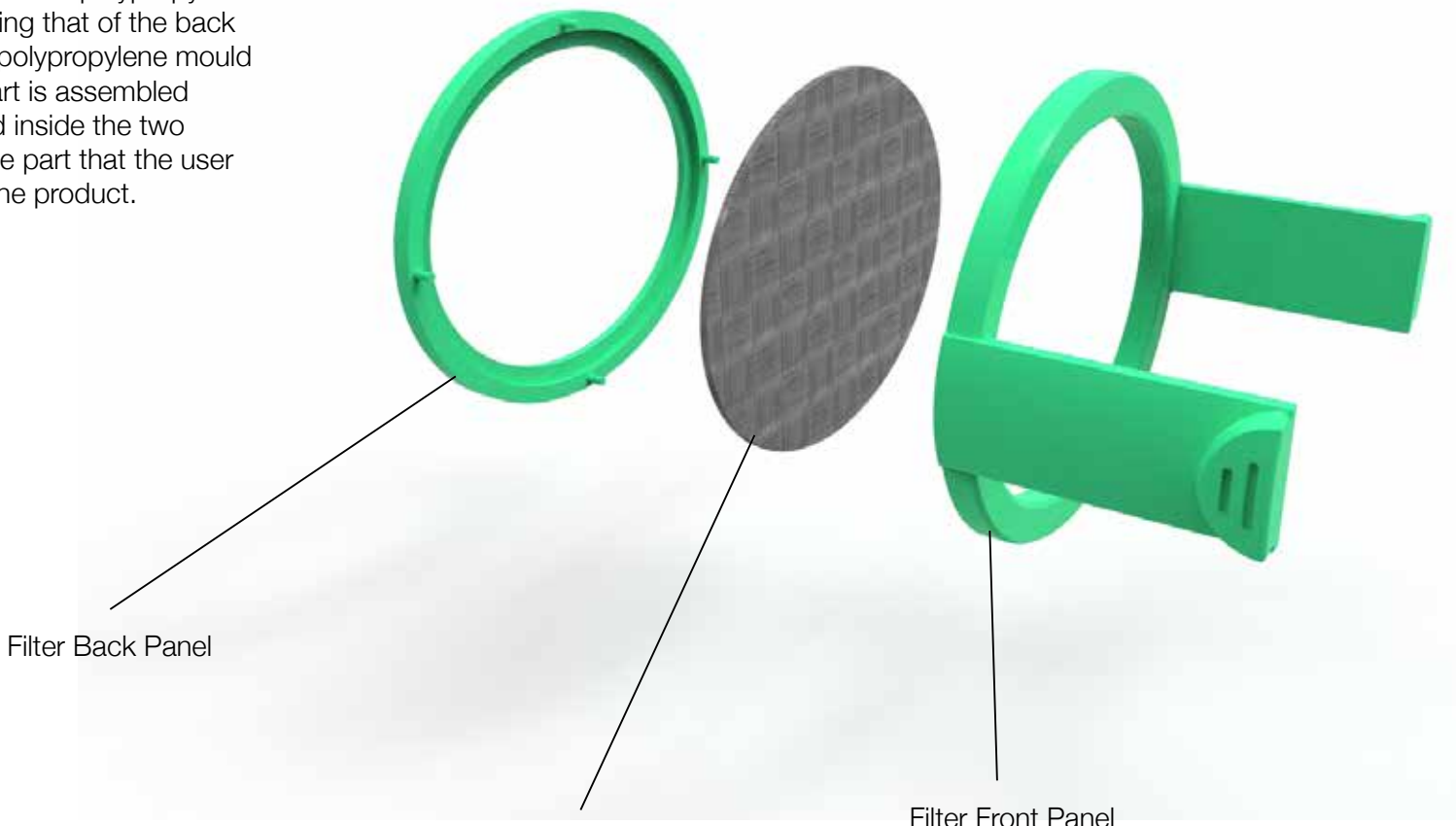
Manufacture - Silicone Mouthpiece

The silicone mouthpiece will be manufactured from an injection molding process. A liquid silicone rubber (LSR) will be the material the mouthpiece is manufactured from. The material properties of LSR can be adapted to suit different needs. For this particular mouthpiece the silicone mouthpiece will be made in medical conductivity grade. This allows the mouthpiece to be durable, chemically resistant, temperature resistant (-60°c to +180°c) and transparent.

The mouthpiece will be fully transparent with a wall thickness of 2mm. Due to the part needing to fit the securely the tolerance level of the mouthpiece will be moulded with a tolerance of ±0.2mm. (Simtec, 2017)

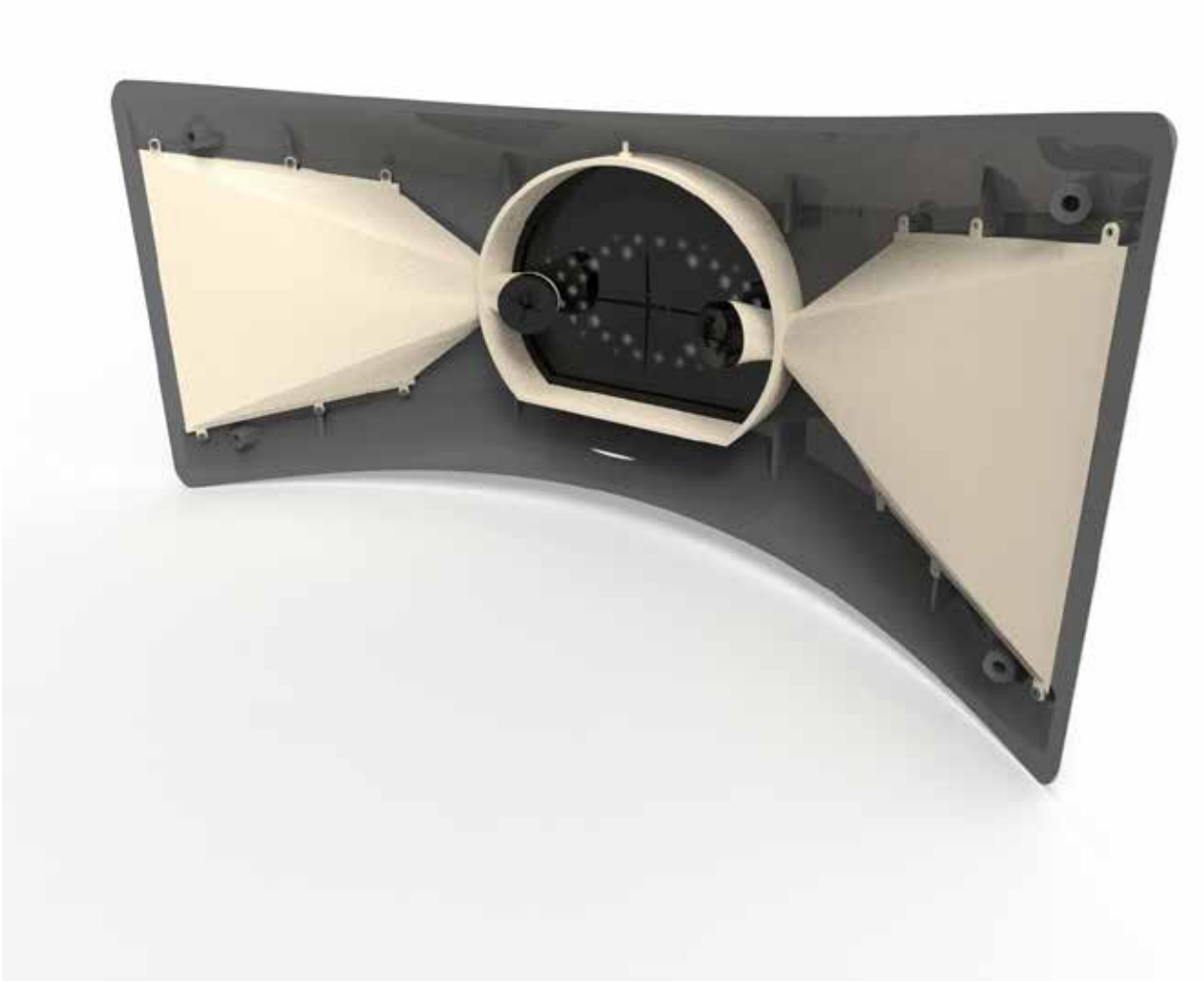
Manufacture - Filter

The sub-assembly of the filter will use three different parts. The filter front arms will be manufactured from polypropylene and finished with a SP1-A2 finish matching that of the back panel. The back ring will be a matching polypropylene mould that will fit inside the front ring, as the part is assembled the high flow carbon filter will be trapped inside the two polypropylene pieces, creating one single part that the user can put in and remove from the rest of the product.



Manufacture - Breathing Internals Sub Assembly

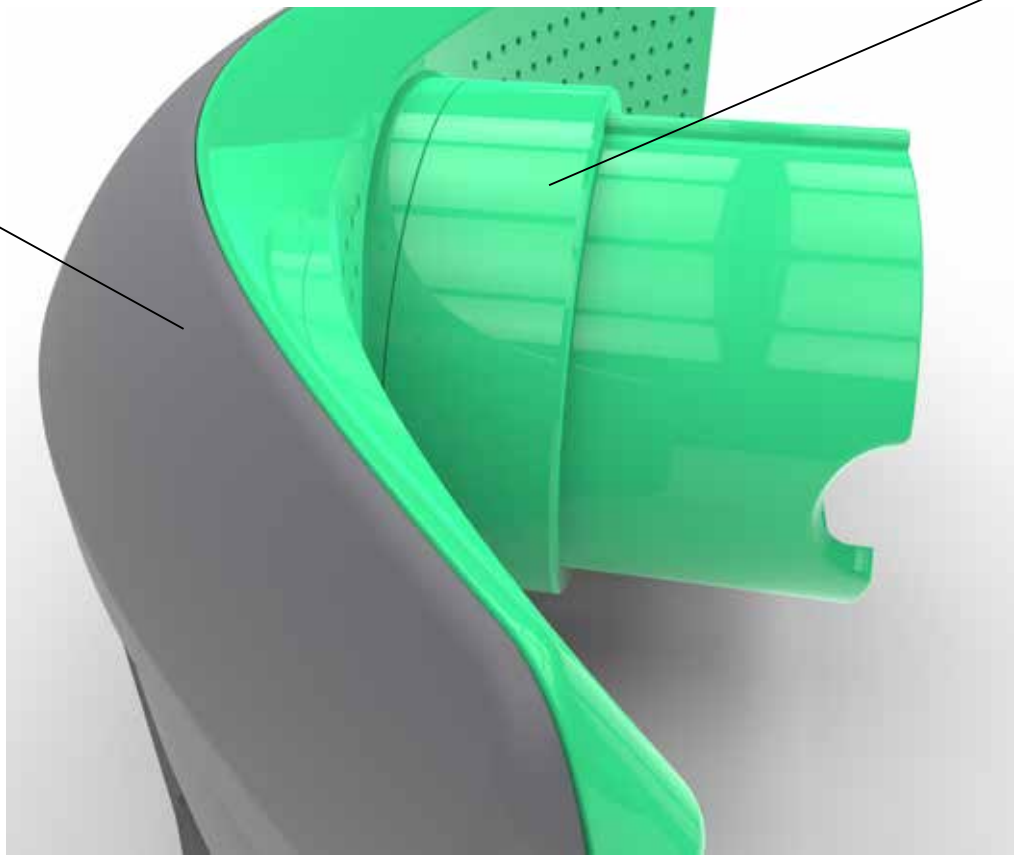
The breathing internals will be another sub assembly within the product. The three air chambers will be manufactured from an uncoloured polypropylene that will use rubber part to form an air tight seal within the product. The two inspiratory air chambers will be screwed in with 12 screws to secure the air seal. The polypropylene parts will have then have the silicone flutter valves input into the parts. These flutter valves will help control the direction of air flow for expiratory and inspiratory breaths.



Manufacture - Material Finishes

The grey satin polypropylene will be finished using a PM-T2 process. This process refers to a medium bead blast after the part is molded. This gives the part a satin surface. The satin finish has been decided on this face to remove the visibility of finger marks on the resistance sliders.

Both parts (grey and green) will then be deflashed and degated. This is the process of removing any excess material on the edges of the product. Cyrogenic Deflashing involves vibrating the part while cooling with liquid nitrogen or dry ice, this allows the excess material to be easily removed.

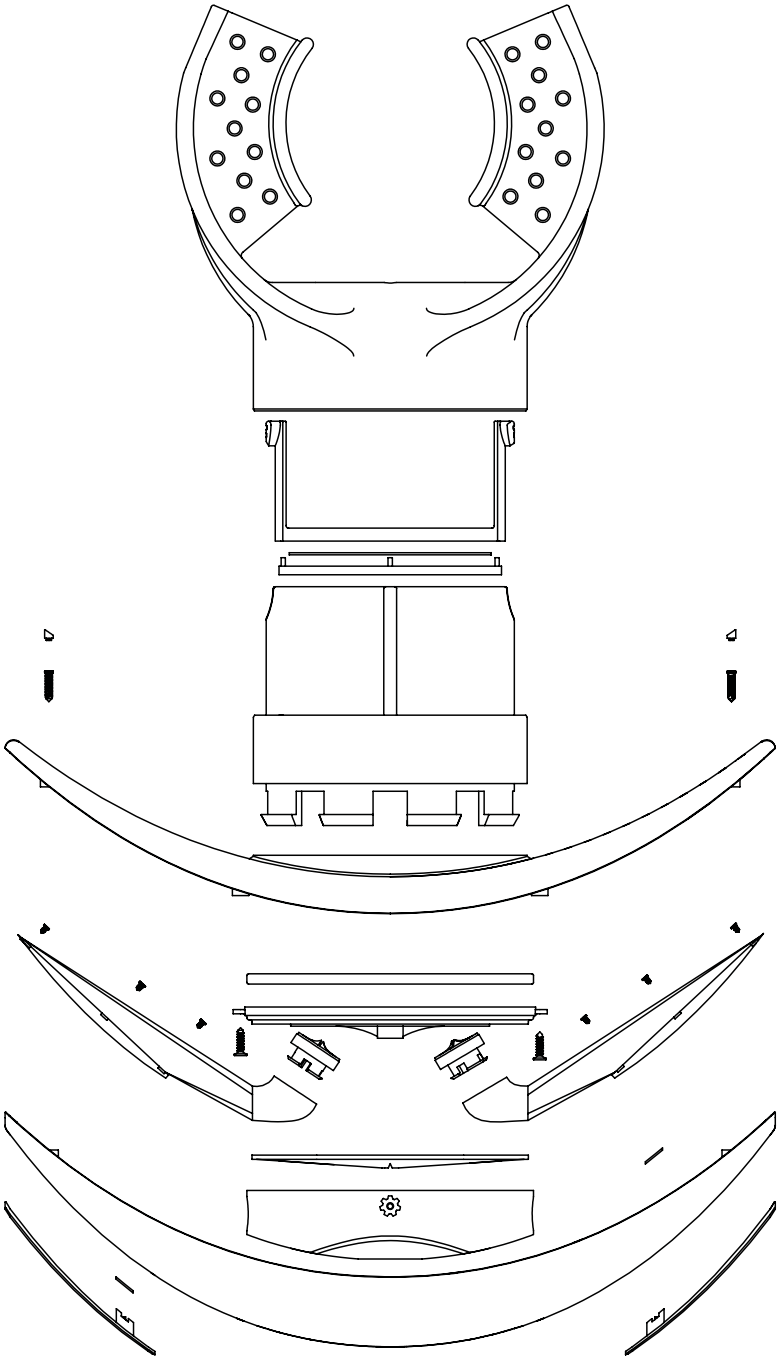


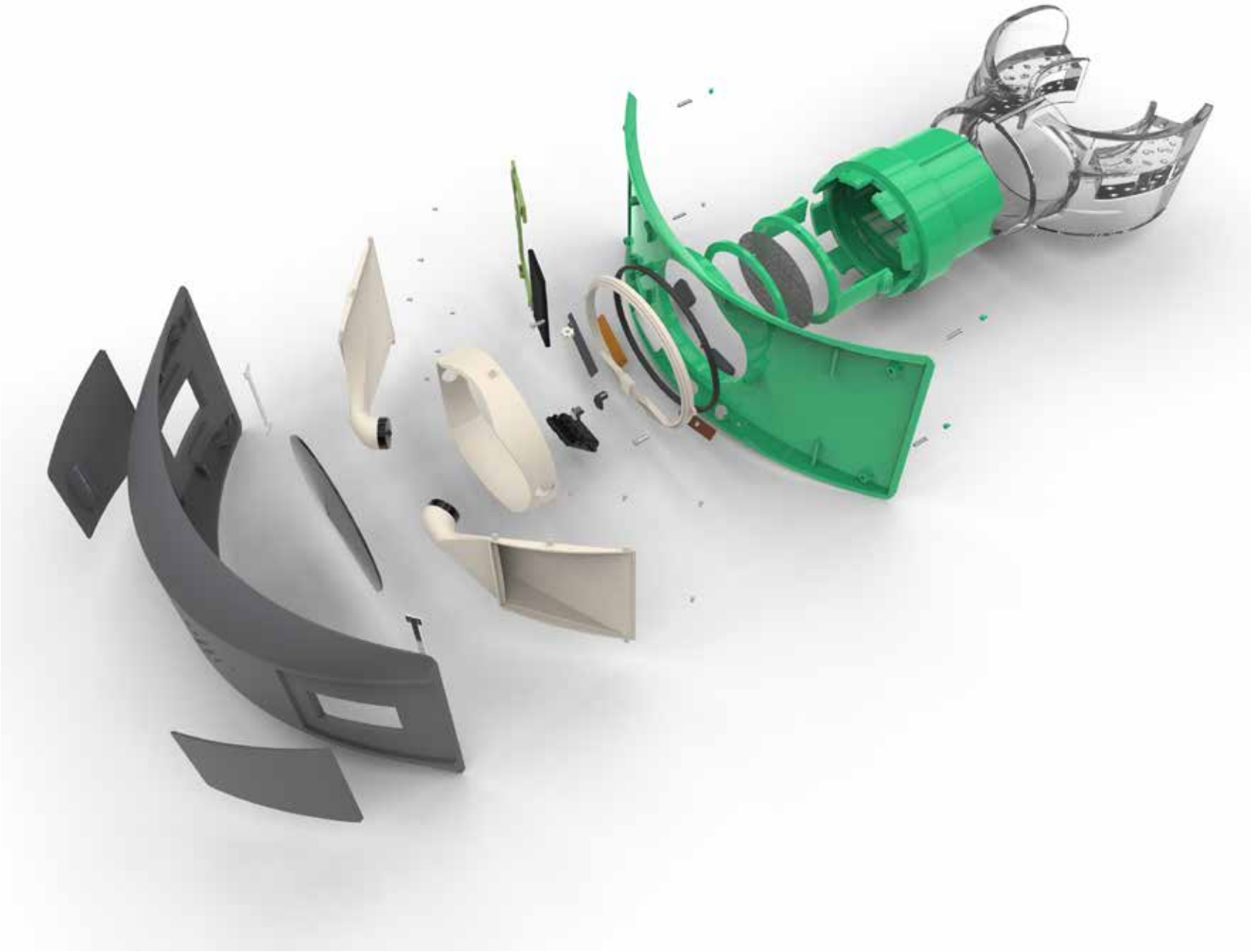
The green polypropylene will be finished using a SP1-A2 finish. This is refered to as a diamond buff finish that creates an extremely glossy finish.

The parts will then be sprayed with a clear hard lacquer that helps enhance the gloss of the part and ensures a scratch resistant surface.

Manufacture - Assembly

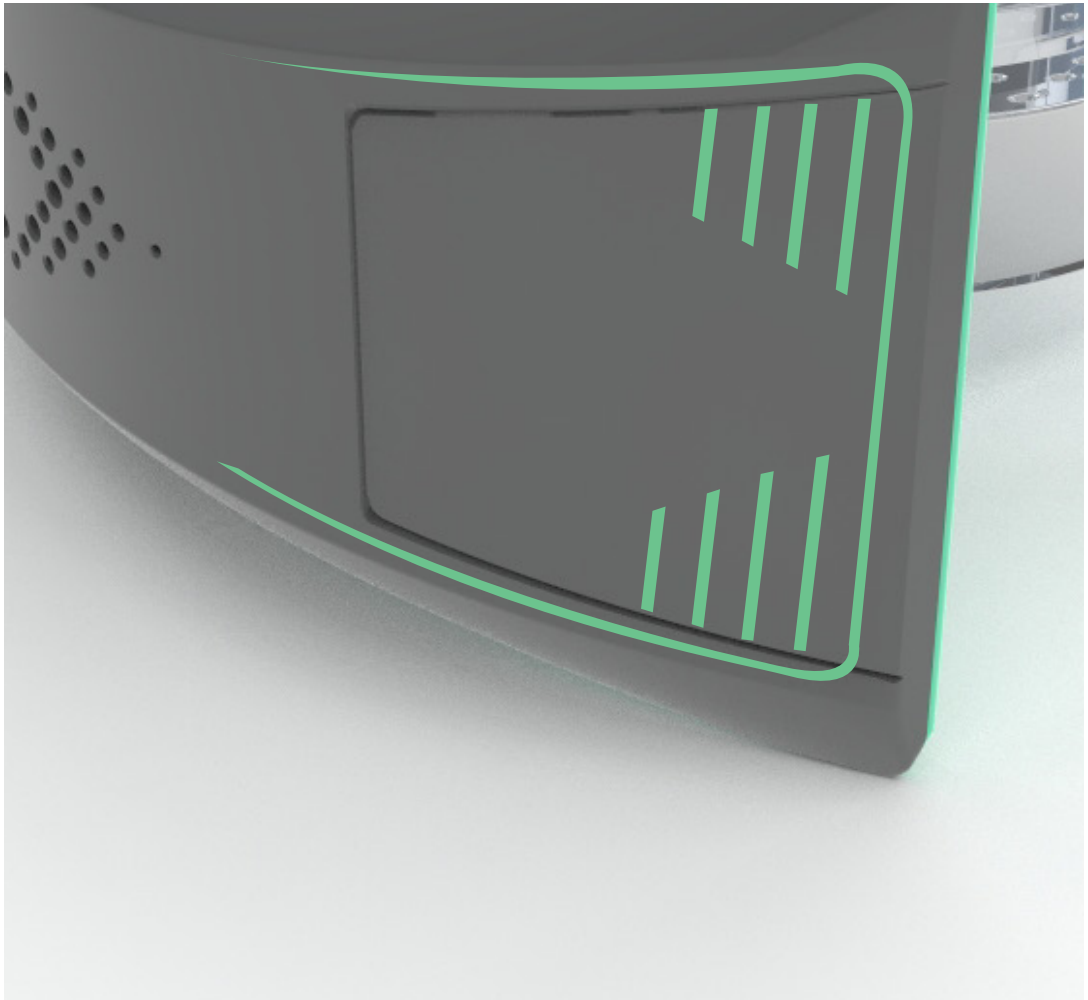
The assembly of the product is not too complex. The exploded view to the right explains how all the components fit together. The breathing sub assembly will be placed within the product first, followed by the electronic sub assembly that is housed on the products back panel. Once the sub-assemblies are put together the back and front panel will be screwed into place sealed with four screw caps. The mouth piece snap fitting will then be pushed into place followed by the carbon filter and the silicone mouthpiece.





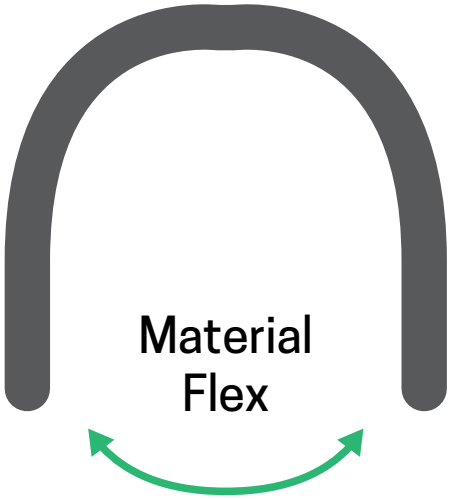
Manufacture - Graphics

The graphics on the product will be placed onto the product using a method called dye-sublimation. This method uses heat to transfer dye onto the material. The reason this particular process has been selected is because of the durability of using a dye-sublimation. Durable graphics that do not scratch off or peel off increase the likelihood of the users keeping the product for an extended period of time.



Manufacture - Nose Clip

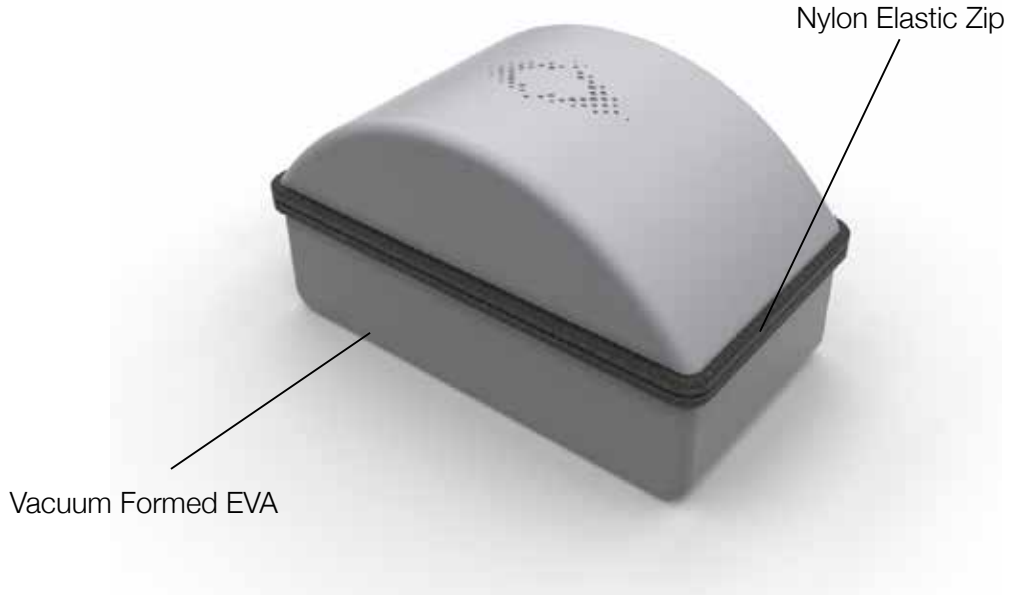
The nose clip will be manufactured from nylon in an injection molded process. A polyamide nylon has been selected for this part to allow the part to flex, it also allows the part to retain it's pressure retention over an extended period of time. The nose clip also features two silicone pads which will be push fitted into place and sealed with an adhesive. (Proswimwear, 2017)

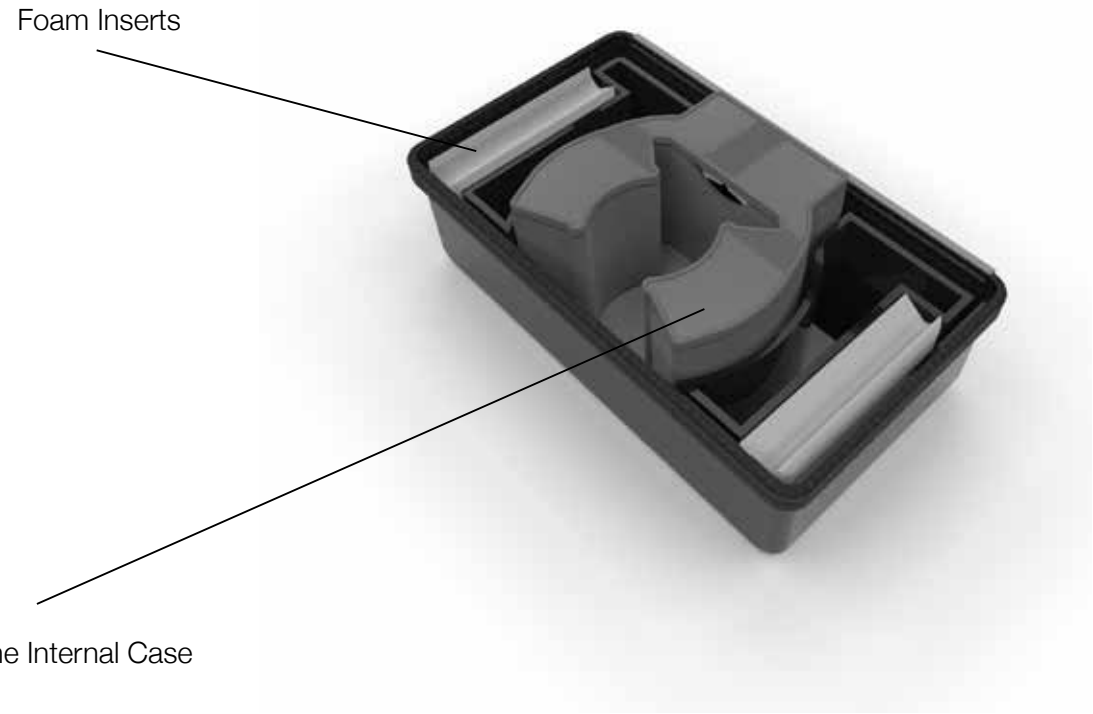


Manufacture - Carry Case

The carry case will be manufactured from an vacuum formed EVA with a wall thickness of 1.5mm. The bottom and top sections to the case will be vacuum formed with a minimum degree angle of 2°. The parts will then be lined with a velvet that is then sewn into the interior of the case to protect that inside. The case will be coloured grey and have the products logo embossed into the top of the case.

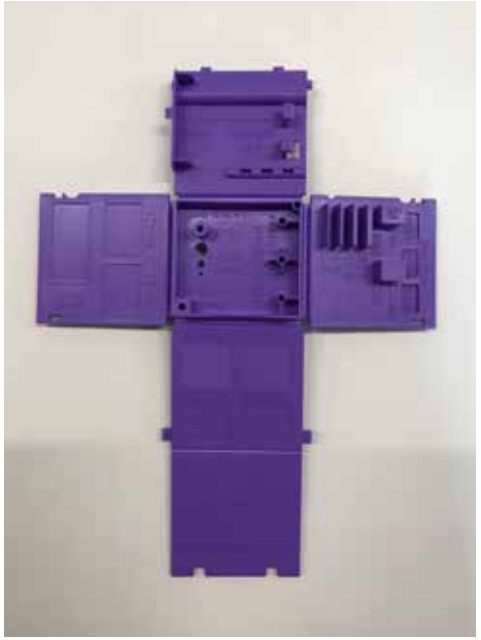
The product will then have a nylon elastic zip sewn around the edges of the product. Inside the case is the polypropylene mouthpiece case that can be removed so the case and mouthpiece can be washed. On the inside of the case is also two foam inserts the position product into position.





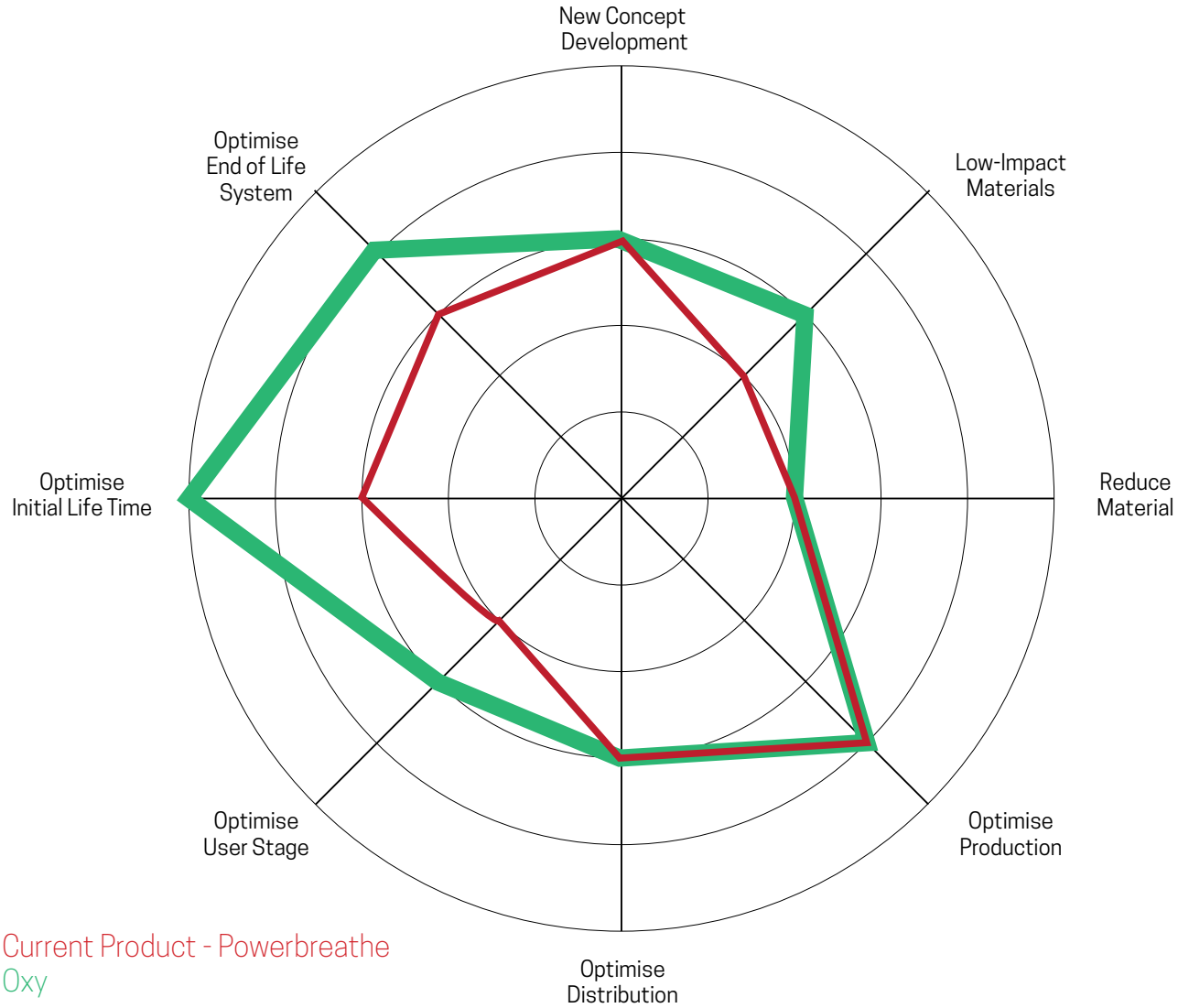
Manufacture - Carry Case

The polypropylene inner case has been designed to store the mouthpiece in a safe and hygienic way. The case will be finished in the same way as the front panel of the product. The case will also have the ability to be removed from the main carry case to be cleaned. The mouthpiece case uses a molded live hinge to open and close it's lid.



Protomold box showing the manufacture of live hinges. The direction of flow within the design will run across the live hinge to give the strength to the part.

Sustainability



Current Product - Powerbreathe
Oxy

As a designer the role of creating sustainable products is vital. Every product designed should have it's sustainability analysed to identify whether anything more can be done to reduce the environmental impact of its production and life cycle. This can be done in other ways than just creating products out of recyclable materials. By increasing the usability and the quality of the product will ensure users look after and keep their possessions longer.

This Ecodesign Strategies Wheel has been put together to analyse the production and life cycle of the proposed concept. Before the sustainability report was created the key topic areas on the wheel were outlined for Oxy.

- Low Impact Materials
- Optimise Production
- Optimise Initial Lifetime

Analysing a product with the Ecodesign Strategies Wheel allows the design to be reflected on to see if their is any way to improve the sustainability of the design.

New Concept Development

This stage of the wheel is focused around the concept of the design and how necessary the product is to society. Due to Oxy being a product considered to be in the leisure category and not having the ability to be shared due to hygiene and in-app profiles means that it struggles to score highly in this section. However,

Oxy being a fresh look on respiratory muscle training gives the users more opportunities to train their lungs compared to any other methods on the market at this time. The filter and mouthpiece are also both inter-changeable components helping the longevity of the products lifespan.

Low Impact Materials

The main components within the product are mostly polypropylene. Although the parts are likely to use virgin material polypropylene is becoming an important and economically viable option on a large scale (Thomas, G. 2012). All other materials can also be recycled and put back into production being mostly thermoplastics.

Reduce Material

Reducing material has been done where possible with the main body using a wall thickness of no larger of 1.5mm. However the product can not reduce material as the will add implications on some aspects of the other sections in the ecodesign wheel due to it compromising the quality of the product.

Optimise Production

The large majority of the design is injection molded from the same material meaning the scale of the production is fairly small. The physical size of the product being so small has a positive impact on the production of the product. The product also requires a small amount of waste due to the manufacturing process.

Optimise Distribution

Due to the product having the ability to be packed into a carry case the distribution of the product will require less packaging than if the product was not part of a family of items.

Optimise User Stage

Due to the part not being overly complex electronically the product is likely to have battery life of around 4 hours. If used every day the product may still only have to be charged once per week. The rechargeable lithium battery also means the product battery is not likely to diminish over time. The product has also been designed in which it asks the user to grow and improve with it (referring to app software), creating an alliance between user and product.

Optimise Initial Lifetime

Due to high quality materials being used for production and surface finishes used the likelihood of the product breaking is significantly improved. The product also has good structural integrity due to the curve in its form. The product has also been designed using colour that is looking forward to say in trend for a number of years after the first batch of production.

Optimise End of Life System

The product can be disassembled due to the product being held together by screws. The product has a limited amount of materials that can all be melted and turned into other products after they are eventually disposed. The only parts that will treated differently other than the electronic components would be the silicone mouth piece. The silicone would not be re-melted but ground into silicone pieces that would be re-used as a filler material for other silicone parts.

Final Concept

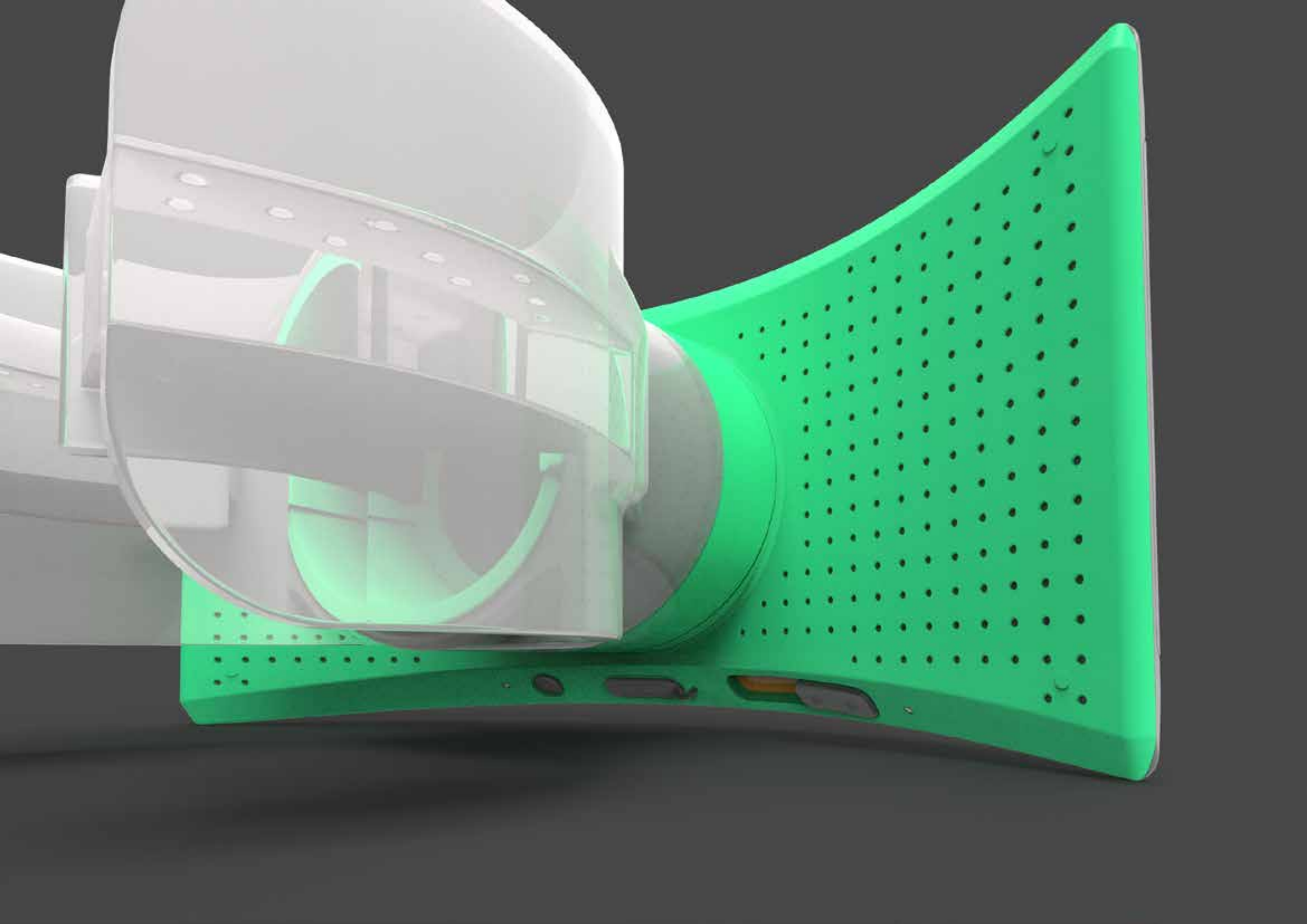

OXY

OXY


OXY


iPhone
4:21PM
OXY
100%
View last training session results
Forced Vital Capacity
Tidal Volume
Respiratory Rate
Start New Session
Dashboard
Results
Coaching
Challenges
Account

OXY



Critical Reflections

The aim of the project was to design a respiratory training device for semi-professional athletes. Looking at other existing respiratory products Oxy was designed in a fresh and exciting way to allow the user to train and improve their physiological and psychological sporting ability. The project was a personal success however, looking back there would be elements and decisions changed to strengthen the design.

Firstly, the discovery of key inspiratory training research which shaped the project into a mouthpiece being discovered earlier would have allowed more time for the design to be developed. The other aspect to the design that could be reconsidered would be the manufacture, although competent, their are aspects within it that could be refined.

Overall, the project was a success and responded to the project brief in a proficient and exciting way. The project has outlined the benefits of bringing respiratory muscle training into users daily regime that has resulted in an exciting product for the consumers.

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All images not referenced are authors own.

Participant Number	Gender	Age	Physical Activities Per Week	Preventing Factors	Where?	What Reason?	Incorporate RMT	RMT Past Experience	Rate Sport Performance	Purchasing
1	M	18-24	0-2 hours	Time	Commuting	Fun	Moderately	No	4	Every Few Months
2	M	18-24	2-4 hours	Work	With A Sports Team	Fun	Probably Not	No	4	Once a year
3	M	18-24	2-4 hours	Money	With A Sports Team	Improve Physical Health	Very	No	5	Monthly
4	M	18-24	4-6 hours	Money	With A Sports Team	Fun	Moderately	No	4	Every Few Months
5	F	18-24	4-6 hours	Time	Gym or Health Centre	Improve Physical Health	Moderately	No	4	Every Few Months
6	F	18-24	0-2 hours	Time	Gym or Health Centre	Social	Very	No	4	Every Few Months
7	M	18-24	6+ hours	Injury	Gym or Health Centre	Fun	Moderately	No	5	Monthly
8	M	18-24	2-4 hours	Time	Gym or Health Centre	Improve Physical Health	Very	No	3	Less than yearly
9	F	45-54	4-6 hours	Work	Gym or Health Centre	Improve Physical Health	Moderately	No		Every Few Months
10	F	18-24	0-2 hours	Work	Other (circus)	Fun	Probably Not	No	1	Less than yearly
11	M	45-54	6+ hours	Work	With A Sports Team	Improve Physical Health	Very	No	5	Monthly
12	M	45-54	4-6 hours	Injury	With A Sports Team	Excitement from Competition	Probably Not	No	4	Every Few Months
13	F	35-44	6+ hours	Childcare	Gym or Health Centre	Part of my job	Moderately	No	3	Every Few Months
14	F	18-24	2-4 hours	Time	Gym or Health Centre	Fun	Probably Not	No	3	Every Few Months
15	F	25-34	2-4 hours	Childcare	Gym or Health Centre	Improve Physical Health	Moderately	No	4	Every Few Months
16	F	35-44	0-2 hours	Childcare	Gym or Health Centre	Improve Physical Health	Moderately	No	2	Every Few Months
17	M	25-34	6+ hours	Work	With A Sports Team	Excitement from Competition	Very	Yes	5	Weekly
18	F	35-44	2-4 hours	Injury	Gym or Health Centre	Improve Physical Health	Very	No	4	Every Few Months
19	F	18-24	6+ hours	Time	With A Sports Team	Social	Moderately	No	5	Monthly
20	F	35-44	2-4 hours	Time	Home	Improve Physical Health	Moderately	No	3	Every Few Months
21	F	35-44	2-4 hours	Work	Gym or Health Centre	Improve Physical Health	Very	No	5	Less than yearly
22	F	25-34	0-2 hours	Work	Gym or Health Centre	Improve Physical Health	Moderately	No	1	Once a year
23	F	25-34	6+ hours	Time	Gym or Health Centre	Part of my job	Moderately	No	4	Every Few Months
24	F	45-54	0-2 hours	Weather	Home	Improve Physical Health	Probably Not	No	2	Every Few Months
25	F	35-44	2-4 hours	Childcare	Gym or Health Centre	Improve Physical Health	Very	No	3	Every Few Months
26	F	35-44	2-4 hours	Childcare	Gym or Health Centre	Improve Physical Health	Probably Not	No	4	Every Few Months
27	F	35-44	2-4 hours	Childcare	Gym or Health Centre	Improve Physical Health	Moderately	No	4	Every Few Months
28	F	35-44	4-6 hours	Childcare	Other (circus)	Fun	Very	No	4	Less than yearly
29	M	75+	6+ hours		Walking	Improve Physical Health	Moderately	No	3	Less than yearly
30	F	25-34	0-2 hours	Childcare	Gym or Health Centre	Improve Physical Health	Moderately	No	4	Every Few Months
31	F	45-54	6+ hours	Childcare	Home	Fun	Moderately	No	5	Monthly
32	F	25-34	4-6 hours	Time	With A Sports Team	Improve Physical Health	Very	No	4	Every Few Months
33	F	18-24	4-6 hours	Work	Gym or Health Centre	Improve Physical Health	Very	Yes	5	Monthly
34	F	35-44	0-2 hours	Work	Walking	Improve Physical Health	Very	No	2	Less than yearly
35	M	18-24	0-2 hours	Time	Commuting	Improve Physical Health	Moderately	No	3	Every Few Months
36	M	35-44	0-2 hours		Home	Fun	Neither	No	3	Every Few Months
37	F	45-54	0-2 hours	Time	Walking	Improve Physical Health	Probably Not	No	3	Once a year
38	F	18-24	2-4 hours	Work	Gym or Health Centre	Improve Physical Health	Moderately	No	4	Monthly
39	F	35-44	0-2 hours	Injury	Gym or Health Centre	Improve Physical Health	Moderately	No	3	Every Few Months
40	F	55-64	0-2 hours	Childcare	Home	Fun	Probably Not	No	1	Less than yearly
41	F	55-64	0-2 hours	Injury	Gym or Health Centre	Improve Physical Health	Very	No	4	Less than yearly
42	F	45-54	0-2 hours	Work	Other (Work)	Part of my job	Probably Not	No	4	Less than yearly
43	F	45-54	0-2 hours	Time	Home		Moderately	No	1	Less than yearly
44	F	18-24	6+ hours	Time	Gym or Health Centre	Improve Physical Health	Moderately	No	4	Every Few Months
45	F	18-24	4-6 hours	Work	Gym or Health Centre	Improve Physical Health	Moderately	No	3	Monthly
46	M	18-24	6+ hours	Injury	Home	Improve Physical Health	Moderately	No	4	Once a year
47	M	18-24	4-6 hours	Time	Gym or Health Centre	Improve Physical Health	Moderately	No	4	Monthly
48	M	25-34	0-2 hours	Time	Home	Improve Physical Health	Moderately	No	2	Less than yearly
49	M	25-34	2-4 hours	Childcare	Gym or Health Centre	Improve Physical Health	Neither	No	2	Weekly
50	M	35-44	0-2 hours	Childcare	Home	Improve Physical Health	Moderately	No	2	Every Few Months
51	F	65-74	4-6 hours	Age	Walking	Improve Physical Health	Moderately	No	3	Every Few Months
52	F	18-24	6+ hours	Time	With A Sports Team	Fun	Moderately	No	5	Weekly
53	M	18-24	6+ hours	Time	Gym or Health Centre	Improve Physical Health	Moderately	No	5	Monthly
54	F	45-54	4-6 hours	Time	Gym or Health Centre	Improve Physical Health	Very	No	4	Monthly
55	F	35-44	0-2 hours	Motivation	Gym or Health Centre	Improve Physical Health	Moderately	No	4	Less than yearly
56	M	45-54	0-2 hours	Time	Gym or Health Centre	Improve Physical Health	Moderately	No	2	Once a year
57	M	35-44	2-4 hours	Motivation	Home	Improve Physical Health	Moderately	No	3	Every Few Months
58	M	35-44	2-4 hours	Work	Gym or Health Centre	Improve Physical Health	Probably Not	No	3	Monthly
59	F	55-64	0-2 hours	Motivation	Home	Improve Physical Health	Very	No	3	Less than yearly
60	F	55-64	0-2 hours	Time	Walking	Improve Physical Health	Probably Not	No	1	Less than yearly
61	F	35-44	0-2 hours	Childcare	Home	Social	Probably Not	No	1	Less than yearly
62	M	18-24	4-6 hours	Time	Gym or Health Centre	Improve Physical Health	Probably Not	No	4	Once a year
63	F	35-44	2-4 hours	Time	Walking	Improve Physical Health	Neither	No	3	Once a year
64	M	25-34	2-4 hours	Childcare	A Club	Fun	Moderately	No	1	Once a year
65	F	35-44	0-2 hours	Childcare	A Club	Fun	Moderately	No	3	Once a year
66	F	25-34	2-4 hours	Time	Commuting	Improve Physical Health	Moderately	No	5	Monthly
67	F	18-24	6+ hours	Motivation	With A Sports Team	Fun	Moderately	No	5	Every Few Months
68	M	45-54	2-4 hours	Motivation	Walking	Improve Physical Health	Moderately	No	3	Less than yearly
69	F	18-24	4-6 hours	Time	Gym or Health Centre	Improve Physical Health	Moderately	No	4	Monthly
70	M	18-24	0-2 hours	Time	Commuting	Improve Physical Health	Moderately	No	3	Every Few Months
71	M	45-54	0-2 hours	Time	Walking	Improve Physical Health	Probably Not	No	1	Once a year
72	M	55-64	6+ hours	Motivation	Walking	Fun	Moderately	No	5	Less than yearly
73	F	18-24	0-2 hours	Motivation	Home	Fun	Probably Not	No	2	Less than yearly
74	M	18-24	0-2 hours	Injury	Commuting	Excitement from Competition	Moderately	No	5	Monthly
75	M	18-24	2-4 hours	Time	With A Sports Team	Fun	Very	No	5	Every Few Months
76	F	18-24	0-2 hours	Money	Walking	Fun	Moderately	No	1	Once a year
77	F	45-54	0-2 hours	Motivation	Gym or Health Centre	Improve Physical Health	Probably Not	No	2	Less than yearly
78	F	18-24	2-4 hours	Money	Gym or Health Centre	Improve Physical Health	Moderately	No	3	Once a year
79	F	45-54	2-4 hours	Work	Gym or Health Centre	Improve Physical Health	Very	No	5	Monthly
80	F	18-24	0-2 hours	Time	Gym or Health Centre	Improve Physical Health	Moderately	No	4	Once a year
81	F	45-54	2-4 hours	Time	Gym or Health Centre	Improve Physical Health	Moderately	No	3	Every Few Months
82	F	25-34	0-2 hours	Time	Walking	Part of my job	Neither	No	1	Less than yearly
83	M	18-24	0-2 hours	Motivation	Walking	Fun	Probably Not	No	1	Less than yearly
84	F	45-54	6+ hours	Time	Gym or Health Centre	Improve Physical Health	Moderately	No	3	Less than yearly
85	F	45-54	2-4 hours	Work	With A Sports Team	Improve Physical Health	Very	No	5	Every Few Months
86	M	18-24	0-2 hours	Time	A Club	Social	Moderately	No	3	Once a year
87	M	55-64	4-6 hours	Time	Gym or Health Centre	Improve Physical Health	Probably Not	No	5	Less than yearly
88	F	35-44	0-2 hours	Time			Probably Not	No		Less than yearly
89	M	45-54	4-6 hours	Time	Gym or Health Centre	Improve Physical Health	Very	No	4	Every Few Months
90	M	45-54	2-4 hours	Time	Walking	Improve Physical Health	Neither	No	4	Once a year
91	M	45-54	0-2 hours	Time	Walking	Improve Physical Health	Moderately	No	2	Less than yearly
92	F	45-54	2-4 hours	Work	Gym or Health Centre	Improve Physical Health	Moderately	No	4	Every Few Months
93	F	45-54	0-2 hours	Motivation	Walking	Improve Physical Health	Very	No	2	Less than yearly
94	F	45-54	0-2 hours	Time	Gym or Health Centre	Part of my job	Probably Not	No	1	Once a year
95	M	35-44	0-2 hours	Work	Gym or Health Centre	Improve Physical Health	Very	No	5	Once a year
96	M	65-74	4-6 hours	Motivation	Walking	Improve Physical Health	Probably Not	No	2	Less than yearly
97	F	35-44	0-2 hours	Time	Walking	Improve Physical Health	Very	No	3	Less than yearly
98	F	18-24	0-2 hours	Childcare	Other (Work)		Very	No	5	Once a year
99	F	18-24	2-4 hours	Time	Home	Improve Physical Health	Moderately	No	4	Less than yearly
100	F	18-24	2-4 hours	Time	Commuting	Improve Physical Health	Moderately	No	3	Less than yearly